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Elmer Lawrence Corthell

IN THE DEATH of Elmer Lawrence Corthell the engineering profession has lost a distinguished member whose professional career was closely linked with three continents. Associated in his younger days with men whose names are indelibly blazoned on American engineering annals—Eads and Morison—he left the United States to gain a distinguished position in Europe and South America, and to return in sufficient season to allow his professional brethren here to show that they, no less than his South American and European confreres, appreciated his sterling character and his singular ability. It was characteristic of Dr. Corthell that on his return to America he should throw himself into the broader professional life with extraordinary energy. Rapidly he picked up the threads of progress here, and with equal rapidity sensed the depth of the movement for giving the engineer his proper place in public life. In such a movement he could not but take an enthusiastic part. His professional work had given him a mastery of financial affairs and brought him into close contact with the leaders of nations. He knew, therefore, the opportunities, and the need, for participation by engineers in public movements. Through his initiative the American Institute of Consulting Engineers became a member of the Chamber of Commerce of the United States and Dr. Corthell devoted much time to the committee work which ensued. He saw in it a great opportunity for public service. He was one of the leaders—if not *the* leader—in the movement to establish a civilian reserve corps of engineers. Closer relations between engineering societies appealed to him as most desirable; in fact, more than twenty years ago he advocated the formation of an engineering society of international scope. The success of the proposal to move the headquarters of the American Society of Civil Engineers to the Engineering Societies' Building was close to his heart. In a word, no subject that meant the advancement of the profession, the improvement of its status before the public, failed to find in him an enthusiastic supporter. Withal, his enthusiasm was tempered by the experience born of the handling of big affairs, while his executive ability never failed to find quickly a plan by which the proposals of which he approved could be made effective. Happily for him, and for the profession, his last years were spent in his own country. By electing him president of the American Society of Civil Engineers and of the American Institute of Consulting Engineers his professional brethren showed that though long separated from him they had followed with pride and interest his distinguished triumphs in foreign fields. "He died in the fullness of years and honors."

N. F. P. A. Takes Significant Action

SIGNIFICANT action by the committee on fire-resistive construction of the National Fire Protection Association was reported and approved at the recent annual convention in Chicago, as noted elsewhere in this issue. The previously adopted terms "full," "partial" and "temporary" protection, as applied to buildings of various classes, are to be applied in the future only to the structural materials and types of construction, and not to the completed structures. Instead, the detailed specifications now to be prepared by the committee for different classes of buildings will recognize three grades in each class—Grade A, Grade B and Grade C. The purpose is stated to be to secure for Grade A the highest practical type of fire resistance, and to have Grades B and C allow for permissible modifications. The practical wisdom of this change in principle, which will permit the future work of the committee to proceed along the lines of best economy for a completed structure, allowing the use of minor structural parts just sufficient in fire-resistive quality for their purpose, is quite evident. On the other hand, it is of vital importance that careful discrimination and judgment be exercised by the committee in permitting and limiting the use of substandard construction in minor parts.

The Typhoid Toll

ENGINEERS who have been unsuccessful in convincing local municipal authorities of the wisdom of an investment in a filtered water supply will find a quantity of valuable ammunition in the paper, "The Typhoid Toll," by George A. Johnson, consulting engineer, of New York, which will appear in the June number of the *Journal* of the American Waterworks Association. Effective use can be made of this material in justifying appropriations for much-needed public-water-supply improvements. City officials, unfamiliar with the recent progress in sanitary engineering, are likely to regard a high typhoid-fever death rate as a necessary evil. They should ponder the New York State Department of Health's motto, "Public Health Is Purchasable," and then weigh carefully Mr. Johnson's statistics. He claims, in effect, that 3000 lives could be saved annually by supplying the urban population of the United States with filtered water or water of equal purity. This figure is based upon the assumption that the typhoid fever death rate could be reduced from 20 per 100,000 population, the figure for 1913, to 14. According to Mr. Johnson's calculations, this reduction represents an amount of vital capital equal to $22,500,000 annually, or, at 6 per cent, the interest on an investment of $375,000,000. Of the 50,000,000 people representing the urban population of the United States 20,000,000 are now supplied with filtered water. To build filtration works having a total daily capacity of 4000 million gallons daily, sufficient to provide for the remaining 30,000,000 people, would not cost $100,000,000. To operate these works and pay all charges, including interest and sinking fund, would cost not more than $12,000,000, or about one-half the present annual loss in vital capital. The remaining $10,500,000 per year in saved vital capital would make a substantial nucleus for a public-health fund to be expended in general disease-prevention work. It would represent 21 cents per capita per year for the entire urban population of the United States and, if expended solely for typhoid prevention, would aid in eliminating this plague.

Engineers in Preparedness Parade

NEW YORK CITY on May 13 witnessed the largest civilian parade in American history. Approximately 125,000 people were in line, and all except about 10,000 were civilians. The demonstration was New York's way of telling how strongly its business and professional men, its employers and employees, desire that the nation be prepared in a military way. Very significant of the depth of feeling was the participation of the professions, and of these engineering easily made the best showing. Upward of 6000 men marched behind the standards of the engineering division, in nine sections—the Engineers' Club, the engineers' training battalion, one section each for the civil, mining, mechanical, electrical, chemical and automobile engineers, and a final section for miscellaneous engineering societies and organizations. The showing was impressive—so much so that the "New York Times" commented especially upon the personnel and appearance of the division. The response of the members of the profession to the invitation of the parade committee, following so closely after the success of the military lectures for engineers, is fitting notice to the military authorities of the country that engineers can be counted on to do their duty when the country needs their services. It is understood that preparedness parades are being planned in other cities—in Chicago, in Boston, in Baltimore, in Buffalo and possibly in other places. These parades will give the engineers of these communities an opportunity to show their fellow citizens where they stand on the subject of preparedness. Judging by the interest displayed in the military engineering lectures from coast to coast, the Engineering Record feels certain that the profession's response elsewhere will be fully equal to the showing at New York.

An Essential in Steel Column Tests

IN THE planning and execution of a series of full-size column tests, there is one essential too often given less attention than its importance demands. In order that the profession may obtain maximum benefit from expensive experiments of this nature, and avoid the future necessity of repeating such tests, both the physical and chemical properties of the component parts of the column section should be accurately determined. It should be possible when a section has been thoroughly investigated to predict within close limits the yield point, provided the compressive yield points of all its component parts are accurately known. By component parts is meant not simply the angles, plates, Z-bars or channels of which the columns are made, but the roots and edges of the angles, the roots, webs and flanges of the channels, and, especially, outstanding portions subject to bending as well as to direct compressive stress.

The theory of column failure, remembering that for all practical purposes failure occurs with the first marked yielding or flow of material under stress, in testing commonly designated as the yield point, indicates that there must be a direct relation between the crippling load, obtained by repeated applications of stress as suggested in the editorial in this journal of May 8, 1915, page 574, and the yield points of the material. The latter yield points should be obtained by compressive tests, for, although theoretically the elastic limit in compression is the same as in tension, the ratio between yield point and elastic limit is not constant, nor is it known just what effects the lack of perfect homogeneity of material and of inaccuracies in testing methods may have on these values.

While recognizing the complexity of the problem of determining the influence of form of section and length of column, the results of any scientific series of tests should make it possible to develop equations in terms of the yield point of the component material which would give closely the relation between this yield point and the strength of any column of given proportions built of that material.

The valuable results now being obtained in the extensive series of full-size column tests being made at the U. S. Bureau of Standards for the American Society of Civil Engineers and the American Railway Engineering Association should furnish sufficient data of this kind to make it possible to test the many varieties of theoretical formulas which have been proposed and to fix finally that formula which will give the most reliable values.

A Great Problem of Cheap Power

AT A RECENT MEETING of the American Institute of Electrical Engineers Lawrence Addicks brought to the front for consideration what is perhaps the most colossal problem in the field of power utilization. This is the provision of cheap energy for the fixation of atmospheric nitrogen. Even in times of peace innumerable industries require the use of nitric acid or its derivatives, of which the ordinary source is the niter dug from the earth. In war time, when the need of nitric acid is enormously increased on account of its necessary use in the making of explosives, the question of adequate supply becomes of prodigious importance. Germany is to-day depending, perhaps exclusively, on artificial nitrates for keeping up the ammunition supply, and without plants at home and those accessible in Scandanavia would fare badly. Since the Chilian nitrate beds, our chief source, might easily be cut off in case of war, the importance of securing the artificial nitrates is plain. In peace we need nitrates badly enough both for fertilizers and for a wide range of chemical industries. In war their possession is necessary to national life.

From the standpoint of the engineer the furnishing of power for this particular purpose is a very grave problem, much more serious than any ordinary question of electricity supply. To make the fixation-of-nitrogen industry self-supporting in times when the natural niter can be obtained, it is necessary to furnish electrical power at a price very much below that which is ordinarily possible. Mr. Addicks states that at even $15 per kilowatt per year, which comes pretty near the minimum of present practice, even in cheap water powers, commercial success is not possible unless the industry furnishes profitable byproducts. Even at half this low price success could only be attained on a large scale, running the works at full load. Improvements are being made in the technique of the processes, but at present it would take half a million kilowatts furnished day and night to make enough nitric acid for a war supply. Such an amount of power cannot possibly be secured as a by-product or spare power. It must be deliberately provided for. It is a task for the engineer, then, to look to means for the production of power on a huge scale and at very low prices, not only for the uses which are here referred to but for the widely varied metallurgical processes which are all-important in giving us materials of construction.

The available sources of power are two; the first, water power which can be developed very cheaply and which is within striking distance by electrical transmission of suitable shipping facilities for getting the product on the market. Scandinavia is rich in such powers, the United States singularly poor. The constructing engineer who sets before himself the problem of buying the power rights and designing a water-power plant which will turn out energy that can be sold at a profit for $7 or $8 per kilowatt-year transmitted to a convenient shipping point has tackled a most difficult job. If the Government can select and aid in developing water-power sites which will give the remotest chance of meeting the conditions, it can find no better use for a few million dollars than in aiding in this development.

The other possible source, by generating very cheap power by steam, is one which should appeal with particular force to the inventive genius of the engineer. If one could work at the very mouth of a cheap coal mine on the basis of producing a steady output of 100,000 kw. or more, some very remarkable figures in economy of power production might be realized. This is a far more practical and reasonable proposition than the general distribution of power from coal mines, which has, however, in a few instances made a moderate success. In the fixation of nitrogen the processes can be made practically continuous, so that a plant delivering power for this task would be able to run at very nearly 100 per cent load factor all the time. It might be possible to combine the power service with a coking plant from which valuable by-products, to be further worked up, might be derived. One of the great English engineers a year or two ago called attention to the great economies which might be introduced by the distillation of coal at comparatively low temperatures with the idea of saving the valuable material and burning the solid carbon refuse, and perhaps the otherwise unneeded gas. The possibilities are inviting.

The situation presented is far too important to let rest as one of the unsolved problems of the future. It is a tremendously big problem. It stands quite by itself, apart from the ordinary requirements of power supply.

Latest Report on Pollution of International Boundary Waters

ONCE more the work of the International Joint Commission is brought to the attention of sanitary engineers. In a report just published suggestions are made as to definite measures for abating the pollution of boundary waters between the United States and Canada and a limit for effective dilution of untreated sewage is fixed. The report, a 159-page document, is by the commission's consulting sanitary engineer, Prof. Earle B. Phelps; an abstract of it appears on page 667. The procedure adopted by the commission in dealing with this problem is as unique in the history of state control of stream pollution as the organization and powers of the commission itself are novel and epoch-marking in the history of the settlement of international disputes.

The treaty of Jan. 11, 1909, between the United States and Great Britain had for its objects, as set forth in the preamble, "to prevent disputes regarding the use of boundary waters and to settle all questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations, or interests of either in relation to the other or to the inhabitants of the other, along their common frontier, and to make provision for the adjustment and settlement of all such questions as may hereafter arise."

To accomplish this purpose in the most direct manner possible the high contracting parties agreed "to establish and maintain an International Joint Commission of the United States and Canada, composed of six commissioners, three on the part of the United States appointed by the President thereof, and three on the part of the United Kingdom appointed by His Majesty on the recommendation of the Governor in Council of the Dominion of Canada."

This commission was organized Jan. 10, 1912. In certain matters dealing with the uses, obstructions and diversions of the boundary waters, the commission has final jurisdiction and may render decisions from which there is no appeal. In these matters, therefore, it sits as an international court of arbitration. In addition, the high contracting parties agreed to refer to the commission from time to time, for examination and report upon the facts and circumstances, together with such conclusions and recommendations as may be appropriate, any other questions or matters of difference arising between them involving the rights, obligations or interests of either in relation to the other, or to the inhabitants of the other along the common frontier. Under this article the commission renders reports and recommendations which are not binding upon the two governments, although the obligation to so refer all matters of dispute is apparently made binding by the wording of the treaty.

Since its organization the commission has been actively engaged in the settlement of disputes that existed prior to that time and that have arisen in the meantime. In a statement before a congressional committee, James A. Tawney, a member, and at that time chairman of the American section, said: "An examination of the record of the work of the commission will disclose the fact that since its organization three years ago the commission has finally settled and adjusted more controversies between the people of Canada and the United States and between the two governments than were previously settled and adjusted through the diplomatic agencies of Great Britain and the United States since the beginning of our government."

The work of the commission has dealt largely with matters of water diversion, lake levels and obstructions to navigation. In August, 1912, however, there were referred to the commission for examination and report with appropriate recommendations, the following questions:

"1. To what extent and by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses?

"2. In what way or manner, whether by the construction and operation of suitable drainage canals or plants at convenient points or otherwise, is it possible and advisable to remedy or prevent the pollution of these waters, and by what means or arrangement can the proper construction or operation of remedial or preventive works, or a system or method of rendering these waters sanitary and suitable for domestic and other uses, be best secured and maintained in order to secure the adequate protection and development of all interests involved on both sides of the boundary, and to fulfil the obligations undertaken in Article IV of the Waterways Treaty of January 11th, 1909?"

The commission immediately organized, under the leadership of Dr. Allan J. McLaughlin, U. S. Public Health Service, the necessary personnel and equipment for a thorough investigation of the first branch of this reference. Dr. McLaughlin had the co-operation in this work of Dr. J. W. S. McCullough, chief officer of health of Ontario, and of F. A. Dallyn, provincial sanitary engineer, and Dr. John A. Amyot, professor of hygiene, University of Toronto. The results of the investigation which was made were reported in detail in a progress report of the International Joint Commission on the pollution of boundary waters issued Jan. 16, 1914. This report probably represents the largest single piece of work of this character which has ever been undertaken. Seventeen field laboratories were utilized and more than 19,000 samples were examined. The total cost of the investigation was about $42,000. The boundary waters from the Rainy River in the northwest to the St. John River between Maine and New Brunswick were included in this study. The report of the sanitary experts in charge of this work established in a conclusive manner the location and extent of pollution which exists in contravention of the terms of the treaty.

Immediately upon the completion of this work and publication of the results steps were taken toward answering the second branch of the reference and the formulation of the final recommendations of the commission. For this purpose a board of consulting engineers, comprising three sanitary engineers of each country, was called together at New York City in May, 1914. Those consulted were George W. Fuller, New York; Prof. George C. Whipple, New York; Prof. Earle B. Phelps, Washington; Fred A. Dallyn, Toronto; W. S. Lea, Montreal, and Theodore Lafrenier, Montreal. The testimony of these engineers was taken in great detail and was later summarized in the form of a résumé, which, in fourteen paragraphs, laid down a set of principles which, in the opinion of the engineers, should guide the commission in its further procedures.

The terms of the reference seemed to place upon the commission the burden of establishing the feasibility and desirability of any recommendations which it might make, and to this end it was decided that a complete preliminary engineering survey of the entire situation was necessary before definite recommendations of remedial measures would be justified. The organization and conduct of this phase of the studies were placed in the hands of Professor Phelps of the U. S. Public Health Service as consulting sanitary engineer. Engineering offices were established at Detroit, Mich., and at Buffalo, N. Y., in charge of Henry C. McRae and Frank C. Tolles, district engineers. These offices were properly organized for the work in hand and immediately proceeded to the preparation of drainage plans, the selection of suitable sites for purification works and the design and cost estimates of purification plants of various types. The Detroit office covered the St. Clair River and Detroit River districts and the Buffalo office the Niagara River district, and plans and estimates were prepared for all communities on both sides of these three rivers.

The work was continued over a period of nine months, and three months' additional time was utilized in the preparation of the final reports of the district engineers and the consulting sanitary engineer. The cost of this investigation was approximately $20,000. This report (see page 667) was presented to the commission at a meeting held in Washington March 8 to 10, 1916, and was accepted and ordered printed in the form of advance sheets. The report of the engineers, therefore, does not constitute the report of the commission upon these matters and it is the purpose, after allowing the cities and towns a suitable time for a study of the results obtained, to hold public hearings at various convenient points at which hearings the federal, state and provincial authorities and the cities interested may have full opportunity to present facts and opinions before the commission. The final conclusions and recommendations of the commission will presumably be based upon a full consideration of the engineers' report and material presented at these hearings.

While the final word still remains to be spoken, the present report carries with it suggestions which, it is reasonable to assume, will govern the commission along three broad principles of policy. In the first place, a definite standard has been proposed to aid in determining whether or not the disposal of raw sewage by mere dilution in a large body of water is permissible. The fixing of 4 sec.-ft. of diluting water per capita of contributing population as a minimum requirement is a matter of considerable economic importance, for upon it hinges the question of the construction or omission of treatment works. Secondly, the recommendation of coarse screening, Imhoff tanks in preference to fine screens, and chemical disinfection indicates what degree of purification the commission considers adequate and what financial burdens the municipalities in the Detroit and Buffalo districts may be called upon to bear. The third significant feature of the report concerns the administration of the remedial works proposed. The jurisdiction of whatever administrative body may be appointed to take charge of this work—and it will be one of considerable size—should be coextensive with the entire system of boundary waters. Then, too, a real solution of the stream pollution problem must be based upon laws so carefully drawn as regards their reasonableness and their consideration of common-law rights as to stand the test of the courts.

Professor Phelps' latest report marks the second important stage of the boundary water question. The first was signalized by the 1914 report, stating the facts in the case. The third will be the actual construction of sewage treatment works.

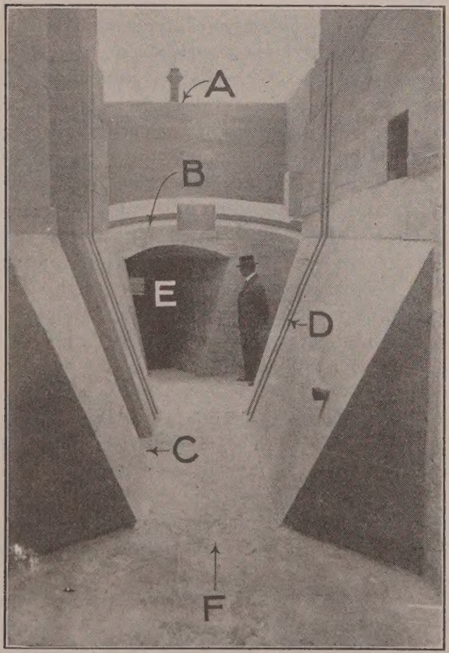
Sewage Screening and Sludge Burning Plant Prevent Sea Shore Nuisances

At Long Beach, Cal., Sewage Passes Revolving Screen—Effluent Discharged into Ocean and Sludge Reduced in Incinerator

IN May, 1913, the construction of a sewerage system for the city of Long Beach, Cal., was authorized, and under a bond issue of $340,000 work was commenced on a system involving 12 miles of mains and laterals terminating in a 48-in. outfall. Machine-made concrete pipe was used for the small diameters, and reinforced concrete for diameters of 33 in. and over. The present population of Long Beach is 35,000; the outfall was designed with sufficient capacity for 125,000 to 150,000. After a careful study of various methods of sewage treatment the engineers retained for this work decided that the use of fine screens would be most advisable. This decision was based on four considerations: Sufficient suspended matter would be removed to render the passage of effluent into the ocean unobjectionable; the cost of Imhoff tanks would be excessive because of the high ground-water level and quicksand along the sewer outfall; a screening plant would occupy but small space and could be housed in an attractive building which would not suggest sewage disposal works; and screenings from the sewage could be completely destroyed by incineration. No attempt at purification of the effluent was made because, after passing the fine screen, it is discharged into the ocean 1100 ft. from shore in 15 ft. of water.

Screen of Revolving Type

The sewage enters the disposal plant through a 48-in. outfall pipe, passes through a Riensch-Wurl screen, then over a weir and into a pump sump. A by-pass is provided so that in case screen repairs are necessary the sewage can be temporarily by-passed direct into the sump. A grizzly, or bar screen, of ½ x 3-in. wrought-iron bars, spaced 2½ in. on centers, is placed in the 48-in. main just above the screen so that all extraneous matter can be removed and taken directly to the incinerator without interfering with the screening process. The screen openings are 1/32 in. in diameter so that only the finest particles will appear in the effluent. These will be readily oxidized and are expected to cause no nuisance in the sea water or along the shore.



SCREEN PIT AND INTAKE CHAMBER BEFORE INSTALLATION OF APPARATUS

A—Wall of screening discharge room. B—Screen setting. C—By-pass. D—Stop-plank grooves. E—Outlet. F—Inlet channel.

In order to obtain a gravity flow for practically the entire city it was necessary to have the water level at the screen at approximately half tide. Under this condition it is necessary to pump the sewage for about one-third of the time while the tide is above this level. Gravity discharge is obtained for about two-thirds of the time during the low tide period. The sludge collected on the screens is consumed in an oil-burning incinerator for which draft is furnished for a 65-ft. chimney. The outfall beyond the screening plant is a 36-in. iron pipe laid along the ocean bottom and anchored with three concrete piles driven to a 20-ft. penetration every 12 ft.

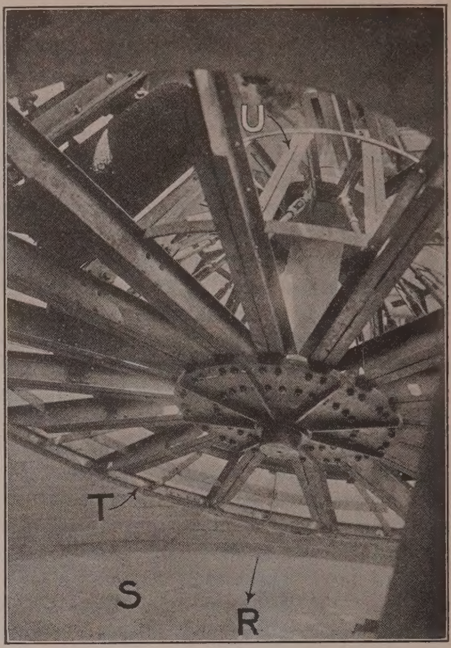
Part of Sewage Pumped

When the sewage is to be pumped it is handled by two motor-driven, vertical, centrifugal pumps, each rated at 1000 gal. per minute. These pumps are automatically started and stopped by a float in a 12-in. cast-iron pipe connected with the outfall beyond the sump. When the tide water rises above a fixed level this float starts the pumps and later cuts off the current when the tide recedes to the same level. In addition to the pump mechanism, an electric motor operating the 36-in. pipe valve through which outlet from the sump is provided is actuated by the same float arrangement, its function being to prevent the backing up of the tide waters through the low pipe outlet channel. The differential installed for this purpose consists of a set of adjustable, renewable contacts on a marble panel connected between two sliding contactors, one on each side, actuated by the float chains. This mechanism is interlocking with the automatic pump starters in such a manner that while the pipe valve is open the pumps are automatically rendered inoperative, without, however, affecting the manual pump control.

The plant is designed for an approximate population of 50,000 with an estimated normal daily flow of 3,750,000 gal. The consumption is designed to handle a maximum daily flow of 5,500,000 gal.

Removing Screenings from Disk

The screen proper consists of a circular plate set on an incline and with its lower part dipping into the sewage as this circular disk is revolved. A device for removing the solid deposits sweeps over the upper exposed part of the disk and transfers the solids to a receptacle in which they are conveyed to the incinerator. The disk is made of rolled manganese bronze plates, ⅛ in. thick, carrying rectangular perforations 1/32 in. wide by 2 in. long, and which widen on the under, or downstream, side. These perforations are so arranged that in the operation of the screening mechanism they will have their long axes parallel to the travel of the cleaning brushes. All of the plates which make up the screen disk are readily removable and each plate fits exactly, so there are no spaces in which solid matter might accumulate. The perforations are machine cut, so that both sides of the plate are free from burrs. The clearance between the screen periphery and the screen chamber is carefully made consistent for the full distance of the screen perimeter and the specifications require this space to be not greater than 1/32 in.



UNDER SIDE OF SCREEN FRAME

R—Screened sewage chamber. S—Screen pit. T—Lower edge of screen. U—Cone frame

The solid matter is removed from the upper part of the screen by brushes sweeping across the screen disk in a direction opposite to that in which the disk is traveling. At the same time that these brushes revolve around their common center they rotate in such a direction that in passing over the screen they do not force the screenings down through the perforations but rather lift them off the disk and roll them along ahead of the brush. At the center of the screen disk its axis is incased in a conical section of screening surface and this is also cleaned by a revolving brush which sweeps the screen in a vertical direction.

The screening disk is so arranged that as the sewage flows against it in the incline position, the effluent passes on through the screen into the outfall while all solid matter is held back and, as the screen rotates, is cleanly removed by the brushes before that portion of the screen again dips below the sewage level.

Movement of Screen

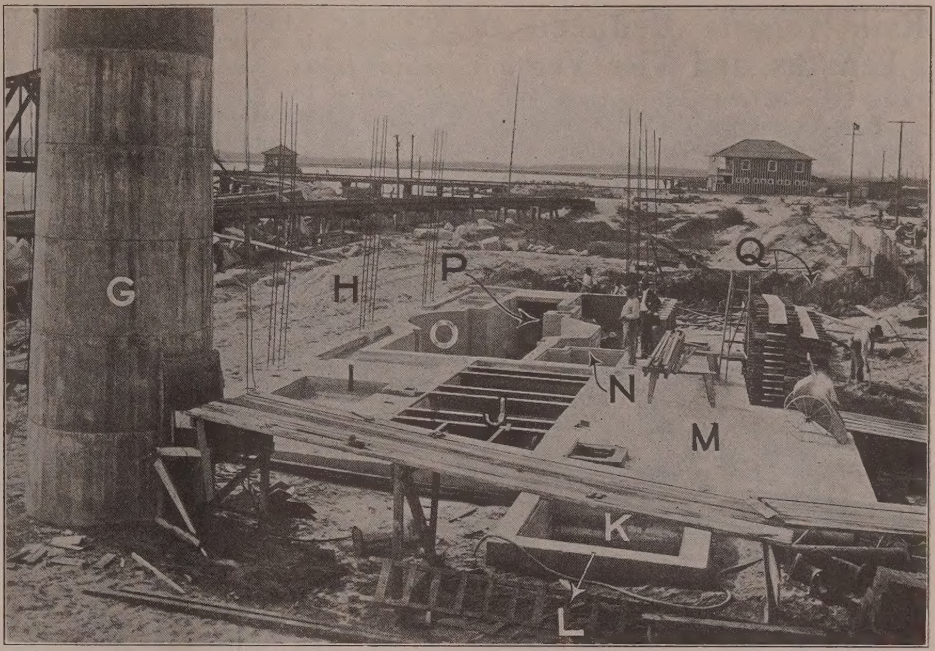
The screen is revolved at the rate of ½ r.p.m. by a three-phase variable speed mtor which has impregnated moisture-proof windings for both rotor and stator, this impregnation being suitable to withstand salt air. The lubricating system for the moving parts of the screen mechanism is fed and regulated from a central point as far as practicable. Borings lubricated by grease are packed and sealed and when near or below the sewage level are equipped with stuffing boxes.

As the solids are swept from the face of the screening disk they pass through a chute into a sludge can standing on a turntable. As the can is filled the turntable is revolved so that an empty can is brought under the chute and the other can be emptied. From this turntable the sludge cans are hoisted to an overhead monorail along which they travel to a position over the charging hole in the top of the incinerator. The cans are 24 in. in dameter, 36 in. high and are equipped with tightly fitting lid and handles for lifting. The plant equipment includes six cans.

INCINERATOR

The incinerator is of the high pressure oil-burning type, designed for the destruction of 1300 lb. per hour of sludge as delivered from the screen containing approximately 80 per cent of moisture. On the basis of 8 hr. continuous operation, its capacity is rated at 10,400 lb. of sludge, equivalent to 150 cu. ft. of sludge on the basis of 69 lb. per cubic foot. The exterior walls of the incinerator are of hard burnt red brick laid in cement mortar and separated by a 2-in. air space of interior lining of 9-in. firebrick. The roof is arched and consists of fireclay blocks grouted to fit the exact interior dimensions of the furnace. The incinerator is set in concrete foundations and is braced by three sets of double 6-in. channels, 9½ ft. long and with tie rods across the top. The four corners have 6-in. angles with tie rods, and 6-in. and 4-in. angles are used for bracing on all four sides.

Passing through the charging hole into the interior of the incinerator the wet sludge strikes an inclined upper drying hearth of special fireclay blocks with 1-in. openings between, through which free liquid passes into the lower section. This is raised at the sides to provide for retention of material without flowing through stoking doors and slightly inclined from front to rear to allow free water to pass through into the concave bottom of the furnace. Between the upper hearth and the concave bottom which serves as an evaporating pan a layer of dry hearth is placed so as to direct the return of the flames and heat. The combustion chamber at one end of the furnace is equipped with a series of baffles of heavy 9-in. fireclay blocks with 6-in. openings, staggered to permit the passing of gases. These baffles become incandescent and are intended to destroy all smoke and combustion gases from the fuel and the burning material. The oil burners are placed in the front end of the furnace in such a manner as to direct the flames first over the material on the drying hearth. From the final combustion chamber the gases pass upon the concrete chimney which is lined with fire brick. The chimney is supported on a concrete piling foundation by a block of reinforced 1:2:5 concrete.



LONG BEACH SCREENING AND DISPOSAL PLANT UNDER CONSTRUCTION

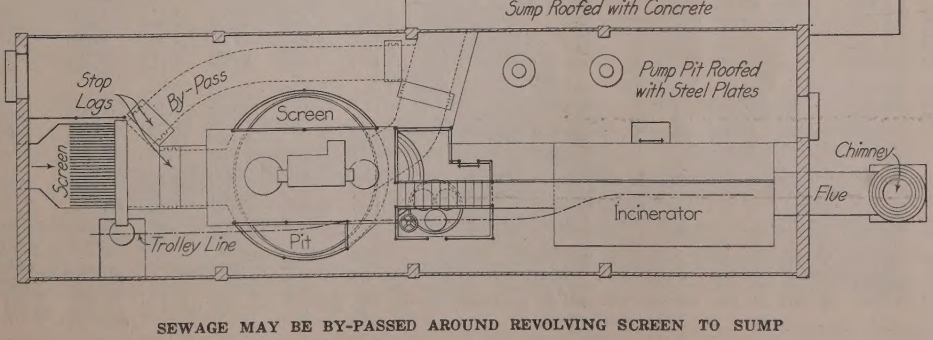
G—Incinerator stack. H—Column reinforcement. I—Incinerator foundations. J—Pump pit. K—Hatch over outlet. L—To outfall pipe. M—Sump roof. N—Screened sewage channel. O—Screen chamber. P—Screen chamber by-pass. Q—Trench for inlet pipe.

Under this reduction process the only residue which has to be removed from the plant is the ash from the incinerator. Since the plant has been in operation handling sewage from a population of about 35,000, the quantity of ash has been about 2 cu. yd. per month. Tests of the sewage which have been made from time to time by the city bacteriologist show that it runs from 87.1 to 88.4 per cent of water. An analysis of the sewage effluent gave the following volumetric results:

Volume of effluent used	350 cu. cm.
Weight of suspended matter (residue on filtration)	0.0953 grams
Weight of suspended matter in grams per liter	0.272 grams
Weight of suspended matter in ounces per 100,000 gal.	3636.3 ounces

The average amount of wet sludge consumed, according to Charles B. Murphy, superintendent of sewers, is 100,000 lb. per month. The burning of this has required 1815 bbl. of fuel oil costing 90 cents per barrel. The total cost of operation, including fuel oil and electric power and two operators at $90 per month, has been found to be $250. This figure represents operation when handling an average daily sewage flow of 2,000,000 gal.

Olmsted & Gillelen, of Los Angeles, Cal., were retained by the city of Long Beach, first in a consulting capacity and later to supervise the construction of the sewerage system and treatment works. Bent Brothers, of Los Angeles, held the contract for the manufacture and placing of the pipe and the construction of the building for housing the screens and incinerator. The screens and incinerator were furnished by the Sanitation Corporation of New York.



SEWAGE MAY BE BY-PASSED AROUND REVOLVING SCREEN TO SUMP

Instructs Road Patrolmen Regarding Their Duties

To impress upon road patrolmen the duties which they are expected to perform, D. H. Winslow, U. S. superintendent of road construction at Durham, N. C., has prepared the following general instructions:

Inspect your road, its entire section, during a rainy day and locate all pond holes.

Use the road drag immediately after a rain.

Fill all depressions with good material.

On no account use worn-out material, sod or sand from ditches.

Remove all glass, tin cans, nails, old iron, etc., from the roadbed.

Renew all defective plank at culverts when necessary.

Should your road surface be very rough, a spike toothed harrow used while the road is wet will improve an earth, sand-clay, topsoil or gravel surface.

Cut the weeds both sides of the road. Use a mowing machine for this purpose if practical.

Cut all brush at inside of the curves and at railway crossings and culverts.

Remove the ridge between the wheel rut and the gutter by using the one-horse cultivator and then use the drag to push the material toward the ditch.

See that all culverts are clear, with outlets and inlets in good order.

Paint all guard rails at culverts and bridges, etc.

Renew all signboards, mile-posts, etc., when necessary and give the traveling public all the advice in regard to the routes within your power.

See that all labor and teams in your employ render full and satisfactory service.

Receive all information and criticism from the general public in a courteous manner.

Rail Weights Reduced to Lengths, and Vice Versa

Tables Compiled for Converting Linear Feet of Eighteen Sections into Tonnages, and Tonnages into Track Miles

By JAMES G. WISHART
Office Engineer, Chicago, Rock Island & Pacific Railway, Chicago, Ill.

THE ACCOMPANYING tables for figuring tonnages and lengths of rail will be found very convenient not only in the engineering departments of the railroads but also in the valuation and auditing departments. Table 1 is especially valuable in the division engineer's office or other offices where estimates for spur tracks are made, and is also a time saver for the valuation department in arriving at the tonnage in existing tracks. Table 2 is useful where the tonnage of rail available is fixed and the length of track it will lay is to be found. This occurs frequently when programs are being compiled for laying rail.

Table 1 gives the weight in gross tons per linear foot for any section of rail from 35 to 120 lb. per yard, inclusive. From this table the total tonnage of any given length of rail can be quickly and accurately ascertained by the addition of two or more quantities. The following example will illustrate the method of using the table: Given 4237 lin. ft. of 80-lb. rail, to find the total tonnage. From the column headed 80 lb. take from opposite 4000 in the first column the amount 47.6190; from opposite 200 the amount 2.3810; from opposite 30 the amount 0.3571 and from opposite 7 the amount 0.0833. The sum of these four quantities equals 50.4404 tons, the weight of the given amount of rail.

Table 2 gives the amount of single track that can be laid with any amount of rail, given in gross tons, for any section of rail from 35 to 120 lb. per yard inclusive. Example: Given 2652 tons of 90-lb. rail, to find the miles of single track which it will lay. From the column headed 90 lb. take from opposite 2000 in the first column the amount 14.1414; from opposite 600, 4.2424; from opposite 50, 0.3535, and from opposite 2, 0.0141. The sum of these four quantities equals 18.7514 miles, the amount of single

TABLE I—WEIGHTS OF RAIL OF VARIOUS SECTIONS IN GROSS TONS PER ANY LENGTH IN FEET (SINGLE RAIL)

Length of Rail	WEIGHT IN TONS 120-lb.	110-lb.	105-lb.	100-lb.	95-lb.	90-lb.	85-lb.	80-lb.	75-lb	70-lb.	67-lb.	65-lb.	60-lb.	56-lb.	50-lb.	45-lb.	40-lb.	35-lb.	Length of Rail
1	0.0179	0.0164	0.0156	0.0149	0.0141	0.0134	0.0126	0.0119	0.0112	0.0104	0.0100	0.0097	0.0089	0.0083	0.0074	0.0067	0.0060	0.0052	1
2	0.0357	0.0327	0.0313	0.0298	0.0283	0.0268	0.0253	0.0238	0.0223	0.0208	0.0199	0.0193	0.0179	0.0167	0.0149	0.0134	0.0119	0.0104	2
3	0.0536	0.0491	0.0469	0.0446	0.0424	0.0402	0.0379	0.0357	0.0335	0.0313	0.0299	0.0290	0.0268	0.0250	00.223	0.0201	0.0179	0.0156	3
4	0.0714	0.0655	0.0625	0.0595	0.0565	0.0536	0.0506	0.0476	0.0446	0.0417	0.0399	0.0387	0.0357	0.0333	0.0298	0.0268	0.0238	0.0208	4
5	0.0893	0.0818	0.0781	0.0744	0.0707	0.0670	0.0632	0.0595	0.0558	0.0521	0.0499	0.0484	0.0446	0.0417	0.0372	0.0335	0.0298	0.0260	5
6	0.1071	0.0982	0.0938	0.0893	0.0848	0.0804	0.0759	0.0714	0.0670	0.0625	0.0598	0.0580	0.0536	0.0500	0.0446	0.0402	0.0357	0.0313	6
7	0.1250	0.1146	0.1094	0.1042	0.0990	0.0938	0.0885	0.0833	0.0781	0.0729	0.0698	0.0677	0.0625	0.0583	0.0521	0.0469	0.0417	0.0365	7
8	0.1429	0.1310	0.1250	0.1190	0.1131	0.1071	0.1012	0.0952	0.0893	0.0833	0.0798	0.0774	0.0714	0.0667	0.0595	0.0536	0.0476	0.0417	8
9	0.1607	0.1473	0.1406	0.1339	0.1272	0.1205	0.1138	0.1071	0.1004	0.0938	0.0897	0.0871	0.0804	0.0750	0.0670	0.0603	0.0536	0.0469	9
10	0.1786	0.1637	0.1563	0.1488	0.1414	0.1339	0.1265	0.1190	0.1116	0.1042	0.0997	0.0967	0.0893	0.0833	0.0744	0.0670	0.0595	0.0521	10
20	0.3571	0.3274	0.3125	0.2976	0.2827	0.2679	0.2530	0.2381	0.2232	0.2083	0.1994	0.1935	0.1786	0.1667	0.1488	0.1339	0.1190	0.1042	20
30	0.5357	0.4911	0.4688	0.4464	0.4241	0.4018	0.3795	0.3571	0.3348	0.3125	0.2991	0.2902	0.2679	0.2500	0.2232	0.2009	0.1786	0.1563	30
40	0.7143	0.6548	0.6250	0.5952	0.5655	0.5357	0.5060	0.4762	0.4464	0.4167	0.3988	0.3869	0.3571	0.3333	0.2976	0.2679	0.2381	0.2083	40
50	0.8929	0.8184	0.7813	0.7440	0.7068	0.6696	0.6324	0.5952	0.5580	0.5208	0.4985	0.4836	0.4464	0.4167	0.3720	0.3348	0.2976	0.2604	50
60	1.0714	0.9821	0.9375	0.8929	0.8482	0.8036	0.7589	0.7143	0.6696	0.6250	0.5982	0.5804	0.5357	0.5000	0.4464	0.4018	0.3571	0.3125	60
70	1.2500	1.1458	1.0938	1.0417	0.9896	0.9375	0.8854	0.8333	0.7813	0.7292	0.6979	0.6771	0.6250	0.5833	0.5208	0.4688	0.4167	0.3646	70
80	1.4286	1.3095	1.2500	1.1905	1.1310	1.0714	1.0119	0.9524	0.8929	0.8333	0.7976	0.7738	0.7143	0.6667	0.5952	0.5357	0.4762	0.4167	80
90	1.6071	1.4732	1.4063	1.3393	1.2723	1.2054	1.1384	1.0714	1.0045	0.9375	0.8973	0.8705	0.8036	0.7500	0.6696	0.6027	0.5357	0.4688	90
100	1.7857	1.6369	1.5625	1.4881	1.4137	1.3393	1.2649	1.1905	1.1161	1.0417	0.9970	0.9673	0.8929	0.8333	0.7440	0.6696	0.5952	0.5208	100
200	3.5714	2.2738	3.1250	2.9762	2.8274	2.6786	2.5298	2.3810	2.2321	2.0833	1.9940	1.9345	1.7857	1.6667	1.4881	1.3393	1.1905	1.0417	200
300	5.3571	4.9106	4.6875	4.4643	4.2411	4.0179	3.7946	3.5714	3.3482	3.1250	2.9911	2.9018	2.6786	2.5000	2.2321	2.0089	1.7857	1.5625	300
400	7.1429	6.5475	6.2500	5.9524	5.6548	5.3571	5.0595	4.7619	4.4643	4.1667	3.9881	3.8690	3.5714	3.3333	2.9762	2.6786	2.3810	2.0833	400
500	8.9286	8.1844	7.8125	7.4405	7.0685	6.6964	6.3244	5.9524	5.5804	5.2083	4.9851	4.8363	4.4643	4.1667	3.7202	3.3482	2.9762	2.6042	500
600	10.7143	9.8213	9.3750	8.9286	8.4821	8.0357	7.5893	7.1429	6.6964	6.2500	5.9821	5.8036	5.3571	5.0000	4.4643	4.0179	3.5714	3.1250	600
700	12.5000	11.4581	10.9375	10.4167	9.8958	9.3750	8.8542	8.3333	7.8125	7.2917	6.9792	6.7708	6.2500	5.8333	5.2083	4.6875	4.1667	3.6458	700
800	14.2857	13.0950	12.5000	11.9048	11.3095	10.7143	10.1190	9.5238	8.9286	8.3333	7.9762	7.7381	7.1429	6.6667	5.9524	5.3571	4.7619	4.1667	800
900	16.0714	14.7319	14.0625	13.3929	12.7232	12.0536	11.3839	10.7143	10.0446	9.3750	8.9732	8.7054	8.0357	7.5000	6.6964	6.0268	5.3571	4.6875	900
1000	17.8571	16.3688	15.6250	14.8810	14.1369	13.3929	12.6488	11.9048	11.1607	10.4167	9.9702	9.6726	8.9286	8.3333	7.4405	6.6964	5.9524	5.2083	1000
2000	35.7143	32.7375	31.2500	29.7619	28.2738	26.7857	25.2976	23.8095	22.3214	20.8333	19.9405	19.3452	17.8571	16.6667	14.8810	13.3929	11.9048	10.4167	2000
3000	53.5714	49.1063	46.8750	44.6429	42.4107	40.1786	37.9464	35.7143	33.4821	31.2500	29.9107	29.0179	26.7857	25.0000	22.3214	20.0893	17.8571	15.6250	3000
4000	71.4286	65.4750	62.5000	59.5238	56.5476	53.5714	50.5952	47.6190	44.6429	41.6667	39.8810	38.6905	35.7143	33.3333	29.7619	26.7857	23.8095	20.8333	4000
5000	89.2857	81.8438	78.1250	74.4048	70.6845	66.9643	63.2440	59.5238	55.8036	52.0833	49.8512	48.3631	44.6429	41.6667	37.2024	33.4821	29.7619	26.0417	5000
6000	107.1428	98.2125	93.7500	89.2857	84.8214	80.3571	75.8929	71.4286	66.9643	62.5000	59.8214	58.0357	53.5714	50.0000	44.6429	40.1786	35.7143	31.2500	6000
7000	125.0001	114.5813	109.3750	104.1667	98.9583	93.7500	88.5417	83.3333	78.1250	72.9167	69.7917	67.7083	62.5000	58.3333	52.0833	46.8750	41.6667	36.4583	7000
8000	142.8571	130.9500	125.0000	119.0476	113.0952	107.1429	101.1905	95.2381	89.2857	83.3333	79.7619	77.3810	71.4286	66.6667	59.5238	53.5714	47.6190	41.6667	8000
9000	160.7143	147.3188	140.6250	133.9286	127.2321	120.5357	113.8393	107.1429	100.4464	93.7500	89.7321	87.0536	80.3571	75.0000	66.9643	60.2679	53.5714	46.8750	9000
10000	178.5714	163.6875	156.2500	148.8095	141.3690	133.9286	126.4881	119.0476	111.6071	104.1667	99.7024	96.7262	89.2857	83.3333	74.4048	66.9643	59.5238	52.0833	10000
1 mile	94.2857	86.4271	82.5000	78.5714	74.6429	70.7143	66.7857	62.8571	58.9286	55.0000	52.6429	51.0714	47.1429	44.0000	39.2857	35.3571	31.4286	27.5000	1 mile
2 miles	188.5714	172.8542	165.0000	157.1429	149.2858	141.4286	133.5714	125.7143	117.8571	110.0000	105.2857	102.1429	94.2857	88.0000	78.5714	70.7143	62.8571	55.0000	2 miles

TABLE 2—LENGTHS OF RAIL OF VARIOUS SECTIONS IN TRACK MILES PER ANY WEIGHT IN GROSS TONS

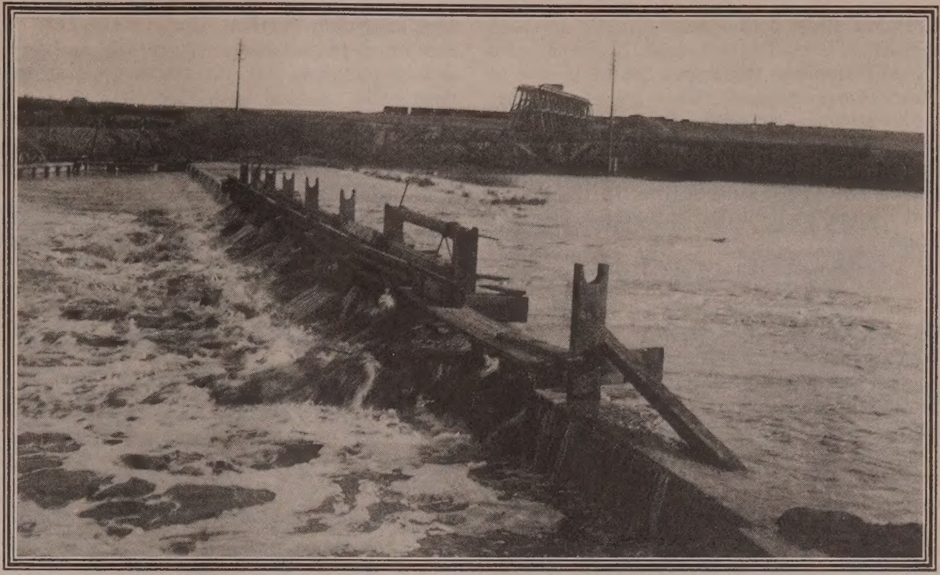
Tons of Rail	LENGTH IN MILES 120-lb.	110-lb.	105-lb.	100-lb.	95-lb.	90-lb.	85-lb.	80-lb.	75-lb.	70-lb.	67-lb.	65-lb.	60-lb.	56-lb.	50-lb.	45-lb.	40-lb.	35-lb.	Tons of Rail
1	0.0053	0.0057	0.0061	0.0064	0.0067	0.0071	0.0075	0.0080	0.0085	0.0091	0.0095	0.0098	0.0106	0.0114	0.0127	0.0141	0.0159	0.0182	1
2	0.0106	0.0116	0.0121	0.0127	0.0134	0.0141	0.0150	0.0159	0.0170	0.0182	0.0190	0.0196	0.0212	0.0227	0.0254	0.0283	0.0318	0.0364	2
3	0.0159	0.0174	0.0182	0.0191	0.0201	0.0212	0.0225	0.0239	0.0254	0.0273	0.0285	0.0294	0.0318	0.0341	0.0382	0.0424	0.0477	0.0545	3
4	0.0212	0.0231	0.0242	0.0254	0.0268	0.0283	0.0299	0.0318	0.0339	0.0364	0.0380	0.0392	0.0424	0.0454	0.0509	0.0566	0.0636	0.0727	4
5	0.0265	0.0289	0.0303	0.0318	0.0335	0.0353	0.0374	0.0398	0.0424	0.0454	0.0475	0.0490	0.0530	0.0568	0.0636	0.0707	0.0795	0.0909	5
6	0.0318	0.0347	0.0364	0.0382	0.0402	0.0424	0.0449	0.0477	0.0509	0.0545	0.0570	0.0587	0.0636	0.0682	0.0764	0.0848	0.0955	0.1091	6
7	0.0371	0.0405	0.0424	0.0445	0.0469	0.0494	0.0524	0.0557	0.0594	0.0636	0.0665	0.0685	0.0742	0.0795	0.0891	0.0990	0.1114	0.1273	7
8	0.0424	0.0463	0.0485	0.0509	0.0536	0.0566	0.0599	0.0636	0.0679	0.0727	0.0760	0.0783	0.0848	0.0909	0.1018	0.1131	0.1273	0.1454	8
9	0.0477	0.0521	0.0545	0.0573	0.0603	0.0636	0.0674	0.0716	0.0764	0.0818	0.0855	0.0881	0.0954	0.1023	0.1145	0.1273	0.1432	0.1636	9
10	0.0530	0.0579	0.0606	0.0636	0.0670	0.0707	0.0749	0.0795	0.0848	0.0909	0.0950	0.0979	0.1061	0.1136	0.1273	0.1414	0.1591	0.1818	10
20	0.1061	0.1157	0.1212	0.1273	0.1340	0.1414	0.1497	0.1591	0.1697	0.1818	0.1900	0.1958	0.2121	0.2273	0.2545	0.2828	0.3182	0.3636	20
30	0.1591	0.1736	0.1818	0.1909	0.2010	0.2121	0.2246	0.2386	0.2545	0.2727	0.2849	0.2937	0.3182	0.3409	0.3818	0.4242	0.4772	0.5454	30
40	0.2121	0.2314	0.2424	0.2545	0.2679	0.2828	0.2995	0.3182	0.3394	0.3636	0.3799	0.3916	0.4242	0.4545	0.5091	0.5657	0.6364	0.7273	40
50	0.2652	0.2893	0.3030	0.3182	0.3349	0.3535	0.3743	0.3977	0.4242	0.4545	0.4749	0.4895	0.5303	0.5682	0.6364	0.7071	0.7995	0.9091	50
60	0.3182	0.3471	0.3636	0.3818	0.4019	0.4242	0.4492	0.4773	0.5091	0.5454	0.5699	0.5874	0.6364	0.6818	0.7636	0.8485	0.9545	1.0909	60
70	0.3712	0.4050	0.4242	0.4454	0.4689	0.4949	0.5241	0.5568	0.5939	0.6364	0.6649	0.6853	0.7424	0.7954	0.8909	0.9899	1.1136	1.2727	70
80	0.4242	0.4628	0.4848	0.5091	0.5359	0.5657	0.5989	0.6364	0.6788	0.7273	0.7598	0.7832	0.8485	0.9091	1.0182	1.1313	1.2727	1.4545	80
90	0.4773	0.5207	0.5455	0.5727	0.6029	0.6364	0.6738	0.7159	0.7636	0.8182	0.8548	0.8811	0.9545	1.0227	1.1454	1.2727	1.4318	1.6364	90
100	0.5303	0.5785	0.6061	0.6364	0.6699	0.7071	0.7486	0.7954	0.8484	0.9091	0.9498	0.9790	1.0606	1.3644	1.2727	1.4141	1.5909	1.8182	100
200	1.0606	1.1570	1.2121	1.2727	1.3397	1.4141	1.4973	1.5909	1.6970	1.8182	1.8996	1.9580	2.1212	2.2727	2.5454	2.8283	3.1818	3.6364	200
300	1.5909	1.7355	1.8182	1.9091	2.0096	2.1212	2.2460	2.3864	2.5454	2.7273	2.8494	2.9371	3.1818	3.4091	3.8182	4.2424	4.7727	5.4545	300
400	2.1212	2.3140	2.4242	2.5454	2.6794	2.8283	2.9946	3.1818	3.3939	3.6364	3.7992	3.9161	4.2424	4.5454	5.0909	5.6566	6.3636	7.2727	400
500	2.6515	2.8926	3.0303	3.1818	3.3493	3.5353	3.7433	3.9773	4.2424	4.5454	4.7490	4.8951	5.3030	5.6818	6.3636	7.0707	7.9546	9.0909	500
600	3.1818	3.4711	3.6364	3.8182	4.0191	4.2424	4.4920	4.7727	5.0909	5.4545	5.6988	5.8741	6.3636	6.8182	7.6364	8.4849	9.5455	10.9091	600
700	3.7121	4.0496	4.2424	4.4545	4.6890	4.9494	5.2406	5.5682	5.9394	6.3636	6.6486	6.8531	7.4242	7.9545	8.9091	9.8990	11.1364	12.7273	700
800	4.2424	4.6281	4.8485	5.0909	5.3589	5.6566	5.9893	6.3636	6.7879	7.2727	7.5984	7.8322	8.4848	9.0909	10.1818	11.3132	12.7273	14.5454	800
900	4.7727	5.2066	5.4545	5.7273	6.0287	6.3636	6.7380	7.1591	7.6364	8.1818	8.5482	8.8112	9.5454	10.2273	11.4545	12.7273	14.3182	16.3636	900
1000	5.3030	5.7851	6.0606	6.3636	6.6986	7.0707	7.4866	7.9545	8.4848	9.0909	9.4980	9.7902	10.6061	11.3636	12.7273	14.1414	15.9091	18.1818	1000
2000	10.6061	11.5702	12.1212	12.7273	13.3971	14.1414	14.9733	15.9091	16.9697	18.1818	18.9959	19.5804	21.2121	22.7273	25.4545	28.2829	31.8182	36.3636	2000
3000	15.9091	17.3554	18.1818	19.0909	20.0957	21.2121	22.4599	23.8636	25.4545	27.2727	28.4939	29.3706	31.8182	34.0909	38.1818	42.4243	47.7273	54.5454	3000
4000	21.2121	23.1405	24.2424	25.4545	26.7943	28.2828	29.9465	31.8182	33.9394	36.3636	37.9919	39.1608	42.4242	45.4545	50.9091	56.5657	63.6364	72.7273	4000
5000	26.5152	28.9256	30.3030	31.8182	33.4928	35.3535	37.4332	39.7727	42.4242	45.4545	47.4898	48.9510	53.0303	56.8182	63.6364	70.7071	79.5455	90.9091	5000
6000	31.8182	34.7107	36.3636	38.1818	40.1914	42.4242	44.9198	47.7273	50.9091	54.5454	56.9878	58.7413	63.6364	68.1818	76.3636	84.8486	95.4546	109.0909	6000
7000	37.1212	40.4958	42.4242	44.5454	46.8899	49.4949	52.4064	55.6818	59.3939	63.6364	66.4858	68.5314	74.2424	79.5454	89.0909	98.9900	111.3637	127.2727	7000
8000	42.4242	46.2810	48.4848	50.9091	53.5885	56.5657	59.8930	63.6364	67.8788	72.7273	75.9837	78.3217	84.8485	90.9091	101.8182	113.1318	127.2728	145.4545	8000
9000	47.7273	52.0661	54.5455	57.2727	60.2871	63.6364	67.3797	71.5909	76.3636	81.8182	85.4817	88.1119	95.4545	102.2727	114.5454	127.2728	143.1819	163.6364	9000
10,000	53.0303	57.8512	60.6061	63.6364	66.9854	70.7071	74.8663	79.5454	84.8484	90.9091	94.9796	97.9021	106.0606	113.6364	127.2727	141.4143	159.0910	181.8182	10,000
50,000	265.1515	289.2562	303.0303	318.1818	334.9282	353.5354	374.3316	397.7273	424.2424	454.5454	474.8982	489.5105	530.3030	568.1818	636.3636	707.0713	795.4551	909.0909	50,000
100,000	530.3030	578.5124	606.0606	636.3636	669.8564	707.0707	748.6631	795.4545	848.4848	909.0909	949.7965	979.0210	1060.6061	1136.3636	1272.7273	1414.1425	1590.9102	1818.1818	100,000

track that can be laid with the tonnage of rail given.

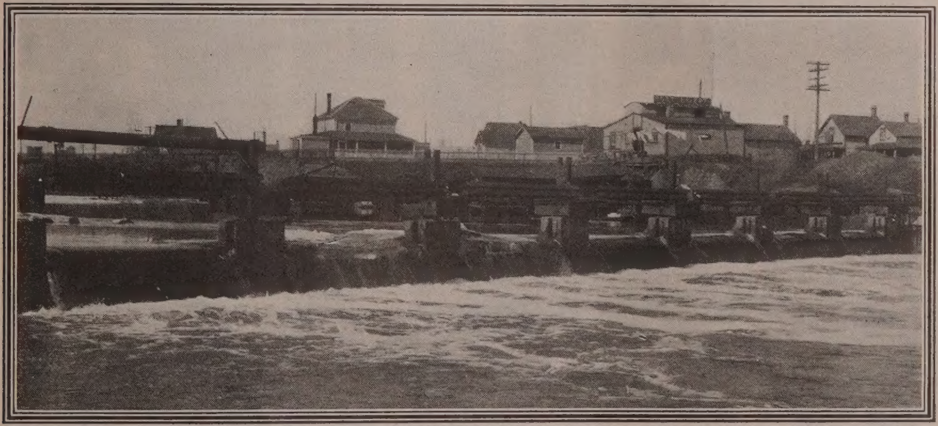
The use of these tables will save many minutes for the estimator, and will give the most accurate results. The fact that the quantities are figured to the fourth decimal place practically eliminates any cumulative error which ordinarily might creep in through the addition of several quantities.

Moose Jaw Dam Failure Followed Sudden River Rise

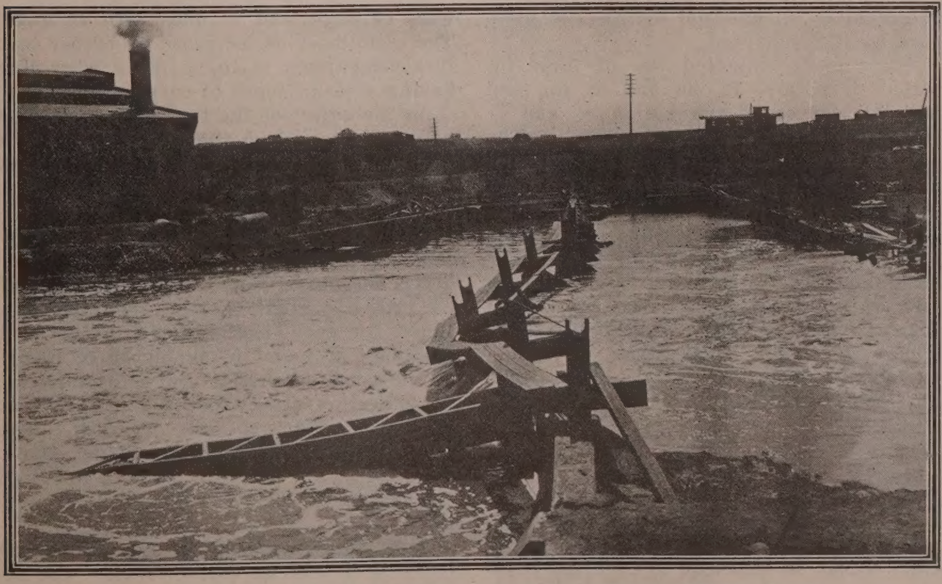
Washing Away of Downstream Rip-Rap Caused Canadian Pacific Structure to Slide 15 Feet on Its Base



MOOSE JAW DAM WAS GRAVITY TYPE CONCRETE STRUCTURE 300 FEET LONG



EIGHT SECTIONS OF THE DAM WERE USED AS FLOOD SLUICEWAYS



AFTER THE FAILURE THE WATER LEVEL IN THE RESERVOIR DROPPED 5 FEET

THE accompanying pictures show the damage to the Canadian Pacific Railway Company's dam at Moose Jaw, Canada, which slid on its base 15 ft. downstream when overtopped by a 6-ft. head of water on April 24, as reported in the news section of the Engineering Record, May 6, page 624.

The dam extended across the Moose Jaw River inside the city limits. It was a gravity type concrete structure 300 ft. long, resting upon a clay foundation, divided by buttresses into eighteen sections. Eight of these sections were used as flood sluiceways, being provided with stop logs to hold water up to the flow line after the floods were over. The dam had no concrete spillways with aprons, but was protected on the downstream face by stone rip-rap.

Moose Jaw River flows only from early in March until about October, being frozen up during the winter months. The drainage area is about 1800 sq. miles, and is almost entirely devoid of tree growth. This lack of timber growth, and the clayey surface-cover of the basin, tend to the rapid collection and delivery of storm water to the main channel. The flow of the river is, therefore, subject to sudden rises during the melting of the snow in the spring, or periods of abundant rainfall.

The reservoir is about $4\frac{1}{2}$ miles long, 700 ft. in width, and about 18 ft. in the deepest portion. After the failure the water level dropped nearly 5 ft.

The spring freshet started April 11 and the water rose until over 6 ft. head of water was flowing over the dam. The stop logs had all been removed before the freshet started.

The failure was due, it is believed, to the rip-rap protection being washed away, which allowed the dam to slide forward on its foundations 15 ft.

Plans Outlined for Abating Boundary Water Pollution

Earle B. Phelps Reports to International Joint Commission on Minimum Standard and Type of Sewage Plants Recommended for Detroit and Buffalo Districts

TO remedy present conditions of pollution of the boundary waters between the United States and Canada Prof. Earle B. Phelps, consulting sanitary engineer, in a 159-page report just issued, has recommended to the International Joint Commission a general type of sewage treatment, with suitable local modifications, comprising coarse screening for the removal of large floating material, sedimentation in Imhoff tanks and chemical disinfection with chloride of lime. The necessary auxiliary plant, sludge-drying beds, chemical mixing tanks, etc., are also provided. The report also prescribes a minimum requirement for the treatment of sewage and fixes 4 sec.-ft. per capita of contributing population as the minimum for effective dilution of untreated sewage with water into which it is discharged. This dilution standard assumes that the pollution of boundary waters cannot be permitted to exceed that which will give 500 B. coli per 100 cu. cm. as a mean cross sectional value. In brief, the engineering studies which have been carried out under Professor Phelp's direction, with the assistance of Henry C. McRae and Frank C. Tolles as division engineers, have developed feasible plans of collection and disposal at all important points on the three most seriously polluted connecting rivers—the St. Clair, Detroit and Niagara—and have determined the upper limits of cost of these improvements. This report, dealing entirely with remedies for sewage pollution, is the second one issued by the International Joint Commission. The first one, issued two years ago, dealt with the extent and causes of pollution injurious to public health.

ADMINISTRATIVE CONTROL

The administrative control of boundary water pollution, the report states, is obviously a federal, rather than a state or provincial, matter. It is recommended that the federal health authorities of the United States and Canadian governments would naturally and logically constitute, or nominate, a joint administrative body for the direct inforcement of a continuing policy of stream protection. In the matter of cost of the improvements proposed it is assumed that the burden of responsibility is individual and to be borne equally by all concerned. This will place a heavier burden upon American cities than upon Canadian.

The report is specific in stating that the oxidizing capacity of streams shall be taken advantage of and that careful attention must be given to the matter of outfall works design.

The report discusses the alternatives of fine screening and sedimentation as the preferred method of treatment and decides in favor of the latter, although it is pointed out that this decision is not necessarily final. No studies were made of the possibility of treating sewage by aeration.

POLICY ADOPTED

In outlining principles to control the pollution of the boundary waters the report states:

"The limit of permissible bacterial pollution shall be deemed to have been exceeded when the effective dilution, as hereinafter defined, shall be less than 4 cu. ft. per second per capita of contributing population, based upon mean river stages during the season May to September inclusive.

"The effective dilution shall be taken as the quotient of the actual physical dilution divided by the residual fraction of the total bacteria remaining after treatment, provided that in the case of the St. Lawrence and other rivers, where the time element is such as to permit some degree of self-purification between points of successive pollution, this factor shall be considered as an element of treatment entering the determination of effective dilution at the lower point.

"In all cases where the actual stream flow below any point of pollution is less than 4 cu. ft. per second per capita of contributing population, or where the net effect of successive pollution with proper allowance for self-purification in the intermediate stretches exceeds the equivalent of one contributing person per 4 cu. ft. per second of stream flow, sewage treatment shall be employed to reduce the net bacterial pollution to a basis of an effective dilution of 4 sec.-ft. per capita, as defined.

"Sewage treatment, while based primarily upon bacterial pollution, shall also include the removal of suspended solids capable of settling to approximately the same degree as is called for in the case of bacteria; provided that this requirement shall not be extended to an unreasonable degree in the light of good engineering practice; and provided, further, that in the case of combined sewer systems, ordinary mineral detritus shall be excluded in computing the degree of removal.

"In all cases where sewage treatment to a specified degree is demanded the entire contributory population shall be dealt with upon the same basis of relative improvement required, so that the net residual pollution from each community shall be proportional to its population."

Tests Show Strength of Corrugated Culvert Pipe

Formula for Working Pressure Developed from Results of Crushing Pipe by External Hydrostatic Pressure

By **GEORGE L. FOWLER**
Consulting Mechanical Engineer, New York

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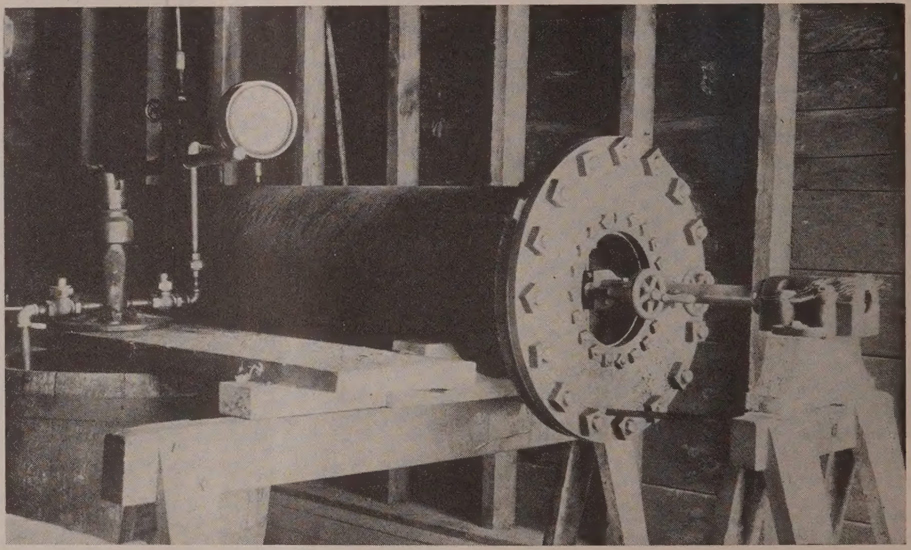
AN investigation has recently been completed looking to the determination of the collapsing strength of corrugated culverts as made of Armco (American ingot) iron. For the hydrostatic tests the pipe tested was placed in a closed cylinder and subjected to an external hydrostatic pressure until it collapsed.



APPARATUS FOR APPLYING EXTERNAL HYDROSTATIC PRESSURE TO CULVERT PIPE AND MEASURING DEFORMATIONS

The pipe investigated was of three internal diameters, 12, 24 and 48 in., and had two depths of corrugation, ½ and ¾ in., with a uniform pitch of 2 2/3 in. The pipe were double riveted on the longitudinal and single on the circumferential seams, with a longitudinal pitch of 2 2/3 in. and a circumferential of about 8 in. The sheets and rivets of all pipe were galvanized. For each diameter of pipe the strength with two depths of corrugation was tested, and for each depth of corrugation the work was done with four thicknesses of metal, namely 16 gage (0.0625 in.), 14 gage (0.078 in), 12 gage (0.109 in.) and 10 gage (0.141 in.).

TESTING APPARATUS

The first tests were made with pipe 12 in. in diameter and 8 ft. long. It was assumed that a total length of eight diameters would be sufficient to avoid all influence of end bracing and support, and this was found to be the case. Each piece of pipe tested was fitted at each end with an internally projecting flange made of angles and riveted to the inside of the pipe. These flanges were faced off parallel to each other and at a distance of 8 ft. apart. They were further drilled for ½-in. bolts to match the head of the casing in which they were tested. A caliper was provided by which any diameter could be measured to within 0.02 in. It was characteristic of all of these pipe that they collapsed suddenly upon the attainment of the maximum pressure.

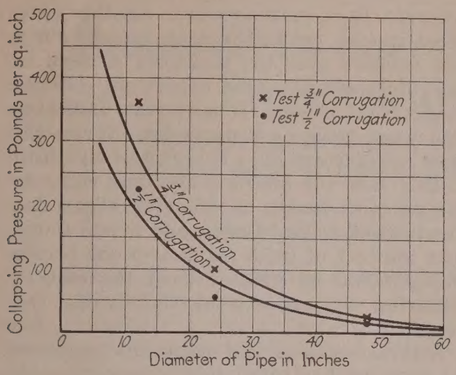
As it is understood that it is safe to conclude that the end support does not influence the strength of the pipe for more than 1¾ diameters on an average, it was considered safe to adopt a length of 12 ft. of pipe of 24-in. and 48-in. diameters that were to be tested, and this was done. Tests were also made, for the sake of comparison, of a set of smooth pipe 12 in. in diameter.

EFFECT OF CORRUGATIONS

On tabulating the collapsing pressures of all of the pipe tested it was found that a ½-in. depth of corrugation increased the strength about 3½ times with 10 gage metal, 5¼ times with 12 gage, 7 times with 14 gage, and 6 times with 16 gage. The ratio must be increased by 50 per cent if a comparison is to be made with pipe having a ¾-in. depth of corrugation.

As the object of the tests was to develop a formula by which the probable strength of other diameters of pipe, made of various thicknesses of metal, could be calculated, that phase of the subject will now be considered. Such a formula, however, can be considered only on the basis of a probability, and not as having been demonstrated as proved. There were three diameters tested for each depth of corrugation and thickness of metal to supply three points on the curve developed from a formula, but the objection arises that the three points may not represent true averages. The pipe was made up in the ordinary course of manufacture and was subject to all of the variations due to that method of treatment.

With this statement of the limitations imposed it will be well to review the results of tabulating collapsing pressures of



COMPARISON OF PRESSURES AT FAILURE

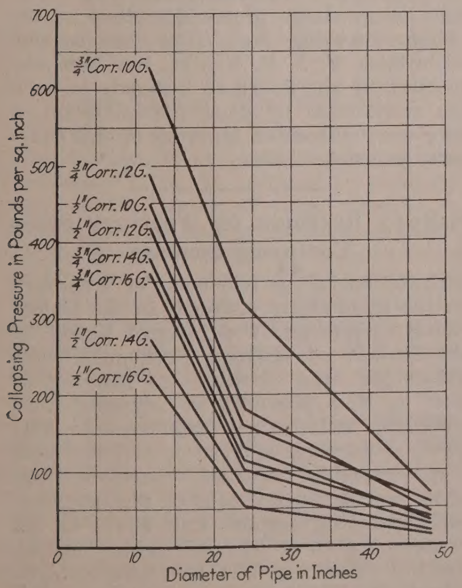
the several pipe tested, as given in the table.

HYDROSTATIC COLLAPSING PRESSURE OF CORRUGATED CULVERT PIPE

Diam. of pipe, inches	Gage of metal	Depth of corrugation, inch	Collapsing press., lb. per sq. in.
12	16	½	225
12	14	½	275
12	12	½	420
12	10	½	450
12	16	¾	360
12	14	¾	380
12	12	¾	490
12	10	¾	630
24	16	½	52
24	14	½	75
24	12	½	130
24	10	½	160
24	16	¾	100
24	14	¾	100 (125)
24	12	¾	180
24	10	¾	320
48	16	½	15
48	14	½	20
48	12	½	33
48	10	½	58
48	16	¾	29
48	14	¾	39
48	12	¾	45
48	10	¾	70

These results are plotted in the accompanying diagram. The lines connecting the several points of failure show that the pressures do not vary inversely as the diameters, as might have been expected and as they are formulated in the rules of Lloyds and the United States for the working pressures allowed on corrugated furnaces.

As between the 12-in. and 24-in. pipe, this ratio holds for the heaviest metal (10 gage) on the smallest pipe. As the thickness of metal decreases the ratio of the collapsing pressure of the 24-in. pipe to that of the 12-in. increases, until with 16 gage and ½-in. depth of corrugation, the ratio becomes about 4½ to 1. While the ratio between the 48 and 24-in. pipe is never less than 1.75 and runs from that to 4½.



COLLAPSING STRENGTH OF 10 TO 16 GAGE CORRUGATED CULVERT PIPE

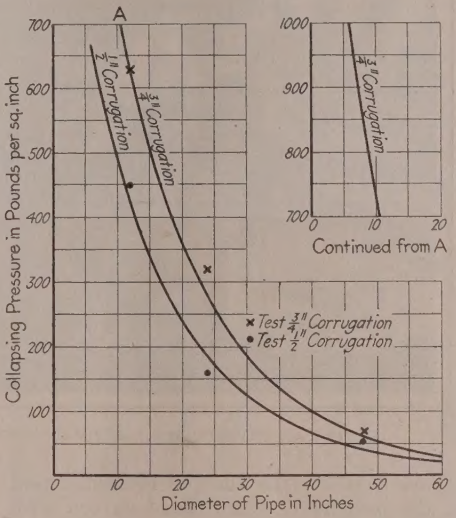
FORMULA DEVELOPED

Considering the three variables—the diameter of the pipe, the thickness of the metal and the depth of the corrugations—the following formula was developed:

$$P = \frac{5960 \times C \times T}{2^{\left(\frac{D-12}{12}\right)}} \times \left(1 - 0.4 \log \frac{D}{12}\right)$$

In which P = collapsing pressure in pounds per square inch; C = depth of corrugation in inches; T = thickness of metal in inches; D = inside diameter in inches.

In the accompanying diagrams of collapsing strength the actual collapsing strength of the several diameters of pipe and for the two thicknesses of No. 10 and No. 16 gage are plotted and lines are drawn.



COLLAPSING STRENGTH OF 16 GAGE CORRUGATED CULVERT PIPE

From this formula it is possible to evolve a simpler approximate formula for the allowable working pressures to which culverts may safely be subjected, assuming that through the narrow range of sizes from about 10 to 24 in., the collapsing pressure varies inversely as the diameter. If, then, we work within this narrow range of sizes, and for a working pressure that bears a ratio of 1 to 2 of the collapsing pressure, the calculation for such a working pressure may be expressed by the formula:

$$P_w = \frac{34{,}000 \times C \times T}{D}$$

in which P_w is the working pressure; the other symbols have the same meaning as before. We thus have a formula identical with that used for calculating the pressure of corrugated furnaces and equally as accurate.

Should it be desired to work to a larger factor of safety, it is merely necessary to make a corresponding reduction in the constant factor of the formula.

The foregoing tests, as also some tests under sand beds, which will be described in another article, were undertaken with a view to securing information preliminary to the planning of tests under sand beds in which conditions of culvert installations in railway practice should be duplicated just as closely as possible.

The succeeding article will describe the methods employed and the results obtained in these practical tests. These results are, of course, those which are applicable to the actual questions arising with regard to railroad and highway culvert installations.

Asphalt Flush Coat Seals Porous Road Surface

Preponderance of Large Particles in Aggregate of Asphalt—Broken Stone Mixture Left Surface Porous to Inch Depth

To seal the surface of a resurfaced road in South Hadley, Mass., which was porous after rolling to a depth of an inch, a flush coat was applied after an unsuccessful attempt was made to make it water-tight by using a finer aggregate. The work was described in detail by E. H. Townsend at the March convention of the Massachusetts Highway Commission. The results, he reports, were excellent.

LARGE PARTICLES CAUSE POROSITY

Though 18 gal. of asphalt per cubic yard coated the aggregate thoroughly, the surface was porous after rolling. This was apparently due to a preponderance of large particles in the aggregate. It became apparent that one of the chief problems would be the attainment of a dense surface, which would seal over during the rolling process.

Subsequent experiments showed that a finer aggregate required more asphalt, the amount being increased first to 20 and then to 21 gal. The resulting pavement was denser than the first, and showed a greater tendency to seal over under rolling. The surface, however, was still porous, and the top particles protruded from the denser part of the pavement from 0.25 to 0.5 in.

No other way of obtaining a more dense pavement with the available aggregate was apparent, and the introduction of more asphalt was found to be impossible. The aggregate was supplied with as much as it would carry, and additional asphalt ran out of the mass and was lost in transit.

COAT WIPED DOWN BY SQUEEGEE

The specifications made no allowance for the introduction of a finer material by adding to the aggregate a sand or fine crusher product. The use of a flush coat to seal over the surface and obtain a watertight pavement was therefore determined upon. The same kind of asphalt was used as in the mixture. It was applied from pouring pots, and wiped down to a uniform thickness with a squeegee, pouring and carrying the strokes lengthwise to the road. About 0.6 gal. of asphalt per square yard was used for sealing, the best results being obtained at not less than 375 deg. Fahr.

Immediately after application the seal coat was covered with clean ¼-in. grit spread at the rate of about 20 lb. per square yard. The flush coat was applied as soon as possible after spreading the mixture, thus placing the coat on a clean, warm surface. No penetration of the stone was required.

At the time of applying, the flush coat was scarcely 1/16 in. thick. The action of traffic gradually pressed the covering of grit into it until it became embodied in the wearing surface, with the result that the coat increased in thickness to about ⅜ in. The resulting surface has a smooth, rubbery appearance similar to asphalt surfaces, and is said to have given excellent service during the seven months of its use.

Queensboro Bridge Floor Strengthened by Adding Stiffeners to Buckle Plates

New 3-Inch Block Flooring with Thicker Concrete of Richer Mix to Replace Old Floor—Tested Satisfactorily on Trial Sections

After many years of trouble for the New York City Department of Bridges and great inconvenience to the traveling public using the Queensboro Bridge crossing the East River in New York City, the plans for reconstruction of the pavement for the roadway have been finally approved, and the necessary fund of $144,000 for proceeding with the work voted by the Board of Estimate and the Board of Aldermen. When the investigation into the reasons for the upheaval and failure of the wood-block paving on the bridge, which occurred in 1911, about 2½ years after the bridge was opened for traffic, was made by the bridge commissioner, the principal cause of the difficulty was found to be the excessive deflection of the steel buckle plates under the old concrete base, causing the latter to break.

The method of remedying this difficulty has gradually developed since the first scheme proposed in the annual report of the Department of Bridges for 1913, and includes the use of stiffener angles to be riveted to the flat parts of the buckle plates, as illustrated in the accompanying drawing. Trial sections, some of which have been in place for three seasons, have shown the proposed method to be satisfactory. The paving will be relaid from the Manhattan anchor pier to Ely Avenue, a distance of 5960 ft., or a total of 33,000 sq. yd. One-half of the roadway will be kept in condition for use at all times. The trolley tracks are to be removed from the roadway between the trusses and carried on the outside brackets, in order to furnish an unrestricted roadway for vehicular traffic, which has increased from a daily average of 2110 in 1910 to 9505 in 1915.

Causes of Floor Failure

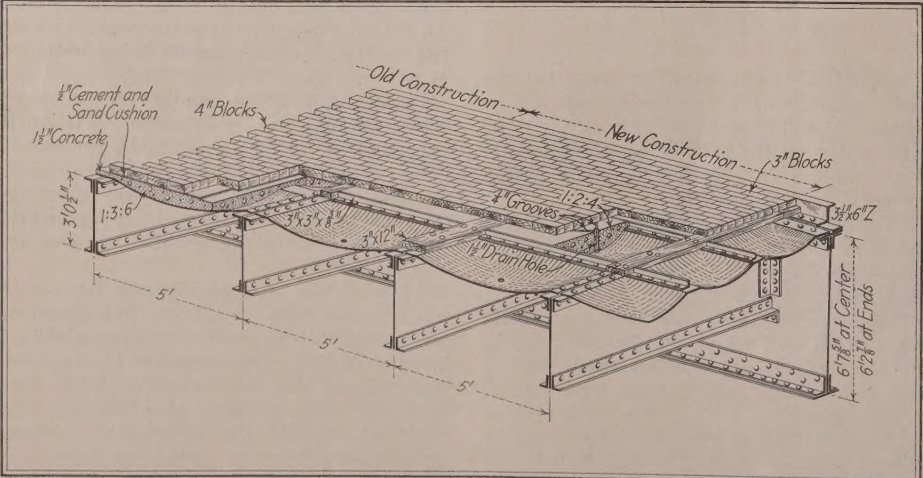
An investigation to ascertain the amount of deflection of the buckle plates was made by using a horizontal timber joist under the flat plate of the buckle plates with nails partly driven to just touch the plate. After allowing traffic to pass for some hours, the nails were found to be driven further into the joints by as much as ⅛ to ⅜ in. under the heavy impact of loads crossing the bridge. These deflecting buckle plates continually developed cracks in the concrete, and the sand and cement cushion on which the blocks were laid, for lack of proper drainage, permitted moisture to collect and caused disintegration of the concrete and consequent great unevenness in the roadway.

A special board of engineers was appointed by the mayor in February, 1916, to report on the plans for the reconstruction of the pavement. This board agreed with the conclusions reached by the Bridge Department as to why the pavement failed, and it also approved the Bridge Department's plan for reconstructing the pavement.

LAYING AN EXPERIMENTAL STRIP OF THE NEW PAVING ON THE QUEENS APPROACH

It will be remembered that the consulting engineers, Boller & Hodge and William H. Burr, who examined the strength of the main trusses in 1908, recommended that the dead weight of the bridge should be decreased before full live-load traffic would be permissible. The repairs to the roadway, therefore, had to be made by using a design which would keep the dead load down to an absolute minimum.

This has been accomplished by adopting thinner wood blocks, a thicker and richer concrete base, with grooves to the weep holes in the center of each buckle plate, and timbers over the stringers as seen in the illustration. The experience of the New York Bridge Department indicates that wood block on a plank floor forms the most satisfactory light bridge flooring. But in this case the buckle plates and concrete act as solid beams to transfer shear due to wind and lateral forces, and it was found that the cost of thick plank over the buckle plates would be greater than the cost of repairing as proposed by the Bridge Department.



DIFFERENCES BETWEEN OLD AND NEW CONSTRUCTION SHOWN BY PERSPECTIVE DRAWING

Several sections laid with this proposed flooring, as illustrated, have given excellent service; three sections completed late in 1913 and one in August, 1915, have all given good results. Steel angles are riveted to the flat parts of the plate, those on the Queens approach being turned upward, while those on the main spans are turned downward. The 3 x 12-in. timber plank over the stringers not only lighten the construction but also act as forms for the concrete, which is easily given a smooth finish. Galvanized iron thimbles are placed in the drain holes, and the concrete is poured around them.

The work will be done under the supervision of Edward A. Byrne, chief engineer of the Bridge Department, New York City, who designed the proposed method of repairing the bridge floor. The commissioner of bridges, F. J. H. Kracke, has been authorized by the Board of Estimate to have the work done by departmental labor—a very unusual method for work of this character and magnitude.

Railway Revenues for February Show Continued Increase

Gross operating revenues for February on the large steam railroads of the United States, according to a bulletin issued by the Bureau of Railway Economics, were $1140 per mile, showing an increase of $240 or 26.8 per cent as compared with February, 1915. Operating expenses were $800, an increase of $120 or 17.7 per cent. Net operating revenue, therefore, was $340—an increase of $120 or 54.8 per cent, and operating income was $287—an increase of $116 or 67.8 per cent. The operating ratio was 70.1 per cent, as compared with 75.5 per cent in February, 1915, and 81.6 per cent in February, 1914.

Proposed Co-operation in Muscle Shoals Project Unjustly Criticised

Characterization of Plan of Private and Government Development as a "Notorious Scheme" Not Warranted by Facts

By H. BURGESS
Major, Corps of Engineers, U. S. A., Nashville, Tenn.

IN VIEW of the inaccurate statements which have been made in public speeches and newspapers in connection with the proposed power development at the Muscle Shoals, Tennessee River, it is believed to be desirable to describe to the engineering profession what has been proposed in connection with this work. This project has been referred to in print and elsewhere as "the notorious Muscle Shoals scheme," and it may be impossible to correct this impression when held by partisan newspapers or those who have some object in attacking this conservation measure. A statement of the facts, however, should be sufficient to convince all disinterested persons that the proposed Muscle Shoals power development has in it no notoriety except that due to there remaining unanswered attacks made upon it by irresponsible or uninformed persons.

The Muscle Shoals section covers the 36.5 miles of the river just above the town of Florence, Ala., and here the Tennessee River is a wide and shallow stream with a fall at low water of 131 ft. In its natural condition the section was impassable for steamboat traffic, and therefore divided the river into two disconnected navigable parts—the lower of 256 miles and the upper of 360 miles. Prior to the Civil War the state of Alabama undertook an improvement of this section, but the resulting benefit to navigation was nothing. In 1870 there was begun an improvement by the United States which contemplated the construction of a lateral canal surmounting these shoals. Inadequate appropriations caused a change in the project, which contemplated that the canal be extended only past the most serious obstructions, and the remainder of the shoals be improved by open channel work in such manner as to make the entire section navigable for as long a period per year as were other obstructions on the river. The slow rate at which money was appropriated caused the completion of this work to be delayed, and it was not opened to traffic until 1891.

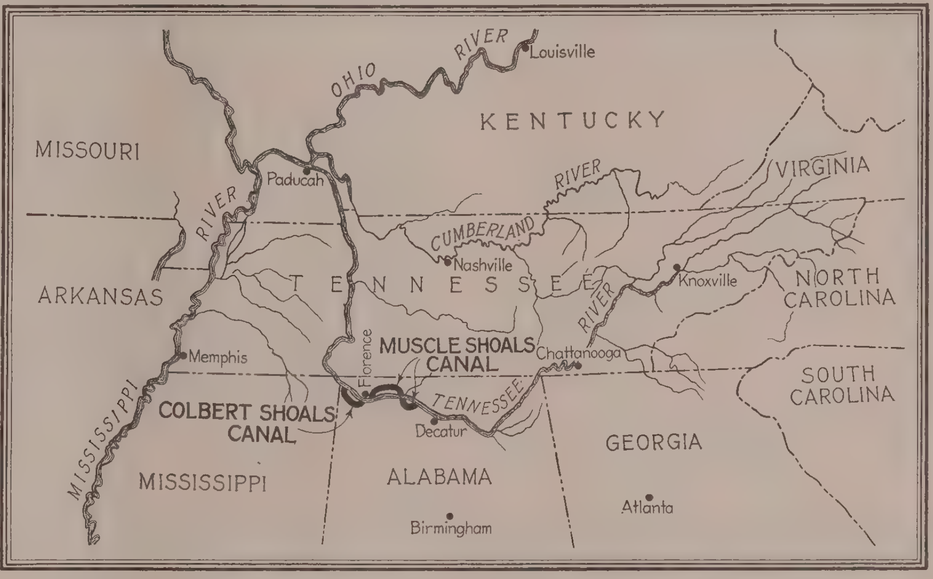
River Traffic Formerly Heavy

In the early years following the Civil War an important traffic existed on the Tennessee River, in spite of an interruption by low water of from four to six months per year, but by the time the Muscle Shoals canal was completed transportation conditions had so changed that a river subject to the handicap of interruption for practically half the year lost tonnage to the improved railway systems. The canal, therefore, has carried since its completion a very unimportant tonnage.

In 1912 Congress adopted for the Tennessee River a plan of improvement which contemplates making Chattanooga the head of continuous barge navigation, but as there was then under investigation a proposed power development at the Muscle Shoals, that section was omitted from the adopted plan. It is obvious, however, that the work of improvement proposed to be done above the Muscle Shoals would be of practically no value unless the barrier to through navigation formed by the Muscle Shoals be removed by a suitable improvement in that section.

Large Potential Power Suggests Co-operation

The large potential power due to the 131-ft. fall and a low-water discharge nearly always of 10,000 sec.-ft. or more attracted the attention of power companies, and in 1908 and 1909 offers were made to the United States which contemplated co-operation between the companies and the United States in the combined improvement. These offers were not favorably considered by the Engineer Department, because of the fact that the extent of the financial co-operation proposed by the companies was entirely insufficient. Undoubtedly the great cost of the long dams and of the locks, and the lack of a satisfactory market for the power, were responsible for the poor offers made.



MUSCLE SHOALS SECTION DIVIDES RIVER INTO TWO DISCONNECTED NAVIGABLE PARTS

The Engineer Department again in 1911, under instructions from the Rivers and Harbors Committee of the House of Representatives, made an investigation for a plan to combine power development with the improvement of navigation facilities. The instructions of the committee directed that advertisement be made and that bids be received from power companies interested in co-operating in this combined improvement. The plans prepared by a special board of engineer officers were sufficiently advanced to permit advertisement March 24, 1913. The advertisement invited bids for co-operation in the development, and requested that separate proposals be made for lease periods of 20, 50 and 100 years.

The bids were opened June 24, 1913, but only two were received. Neither was entirely satisfactory from the financial standpoint, and neither considered any but the long-term franchise. On this account the board made further investigation and revised its plan so as to eliminate one of the dams and power houses by an increase in height of the other two. The revised plans also included a navigable improvement of the 46 miles of river above the Muscle Shoals section, with the addition of 9 ft. to the total power head. Advertisement inviting bids was again made Aug. 28, 1913, and the opening was fixed for Dec. 11, 1913. One of the June bidders repeated his offer, but made no change because of the increased power head. The other made an offer which appeared to be satisfactory, and it is the one described below.

Government Expenditure Limited to $8,575,000

In each of the investigations made by the Engineer Department the boards of officers laid down as an essential condition that the portion of the total cost to be paid by the United States must not exceed the estimated cost of providing satisfactory navigation facilities through the Muscle Shoals section. A plan of improvement for the 82.5 miles of river considering only navigation facilities was prepared, and it was estimated that the cost would be $8,575,000. With such an improvement, power development would be impracticable, as the plan contemplated an extension and improvement of the present canal system.

The plan under which the advertisement of August was made provided for locks, dams, substructures of power houses, and tailraces, and the cost was estimated at $18,701,000. Under the above stated condition, therefore, no offer could be considered favorable unless it provided for a payment by the power company of at least $10,126,000.

One of the offers proposed a cash payment at the beginning of the lease period of $6,250,000. The other bid was from the Muscle Shoals Hydro-Electric Power Company, a subsidiary organization of the Alabama Power Company, and, as explained below, the final cost to the United States under this offer would be very much less than $8,575,000. The offer submitted was discussed by representatives of the power company with the board, and the final agreement proposed that the franchise should be awarded to the power company upon the following terms:

1. The United States to construct locks, dams and substructures of power houses, and to excavate the tailraces; the power company to construct superstructures of power houses and make all installations connected with the power development.

2. The power company to furnish detail plans for the substructures of the power houses, such plans providing structures not more costly than those estimated on by the board, or all extra cost to be borne by the power company.

3. The power company to have a 100-year lease of the power developable at the two dams, the lease to begin upon completion of the first dam.

4. The power company to pay $3,000,000 cash upon completion of the first dam.

5. The power company to make the following payments to the United States:

At the end of the first year following the completion of the second dam..........	$75,000
At the end of the second year............	125,000
At the end of the third year..............	150,000
At the end of the fourth year.............	175,000
At the end of the fifth year...............	200,000
At the end of the sixth year, and at the end of each year thereafter until the close of the lease period..	240,000

6. The power company to pay in cash to the United States at the end of each year an amount equivalent to 35 cents per year per horsepower of installed capacity, as measured at the switchboards of the power houses, such payments to begin at the end of the first year after the installed capacity reached 200,000 hp., but in any event not later than the end of 20 years from the beginning of the lease.

7. The power company to furnish to the United States, free of charge, delivered at the locks, electric current sufficient for operating the locks and the government shops and boat yard—not exceeding 200 hp.

8. The power company to maintain and operate the dams and to maintain power houses and equipment in first-class condition throughout the lease period.

9. The United States to control the regulation of river flow during the period of the lease, in order to prevent interference with navigation in the open channels of the river below Florence.

10. The United States to be the owner from the beginning of the locks, dams, substructures of power houses, and lands, and to become the owner of the power houses and such transformer houses as might be located on the land belonging to the United States at the end of the lease period, and the power company to remain the owner of all installations connected with power development.

TERMINATION OR RENEWAL OF LEASE

11. The following provisions for the termination or renewal of the lease: At any reasonable time prior to the expiration of the lease, and upon the invitation of either party, the United States and the power company shall discuss, and, if practicable, agree upon terms for the renewal of the lease. If agreement on such terms is reached, the lease shall be renewed under the conditions agreed on; but if the contracting parties fail to agree on terms for such renewal, the lease shall be terminated at the end of the 100-year period, and the United States shall take possession of all property of the power company used for the development and transmission of electric power, and shall pay to the power company a price which may have previously been agreed upon between the contracting parties, or, in the event of failure to so agree, shall pay to the power company for the property so taken a fair value to be determined by condemnation proceedings usual in the states wherein the property is located, and the United States shall, upon so taking possession, assume all contract obligations of the power company to deliver electric power which comply with the terms of condition 12.

12. In connection with contracts to be made by the power company for delivery of power, the following provision: All contracts for the delivery of electric power extending beyond the end of the 100-year lease period shall be submitted by the power company to the United States for approval; and in the event that such contracts are approved, or in the event that they are not disapproved within a period of three months from the time of receipt by the United States, they shall be binding on the United States as provided in condition 11. No contract disapproved by the United States, nor any contract not submitted for approval in accordance with the requirements of this condition, shall be binding on the United States in case the latter takes over the property of the power company.

13. The United States to be allowed at any time after the end of 50 years to terminate the 100-year lease and take possession of all property used for the generation and distribution of power, upon payment to the power company of its value as a going concern—a condition recommended by the Board for Rivers and Harbors, which reviews the reports of all subordinate boards.

14. The power company to execute a bond with approved securities for an amount not less than $1,500,000, to be prescribed by the Secretary of War, the period of the bond to extend until the cash payment of $3,000,000 be made.

Under the conditions stated, the amount to be appropriated by the United States for the structures and for flowage damages would be $15,701,000, the remaining part of the estimated cost, $3,000,000, being furnished by the power company.

FINAL COST TO UNITED STATES

In order to determine what the final cost to the United States would be, all annual payments are reduced to "present worth" at the beginning of the lease period. The fixed payments, not dependent upon installation, at 3 per cent compound interest, have a "present worth" of $7,128,000. Payments upon installation depend so much on the success of the company in marketing power that nothing more than estimates can be given. Three suppositions have been made, which may be designated as "success poor," "success good" and "success excellent." The first assumes that 200,000-hp. installation will not be reached until the end of the 20th year, and that for each decade thereafter there is added an installation of only 20,000 hp. Upon the basis of this installation, using the 3-per cent compound interest rate, the present worth of the payments is, at the beginning of the lease period, $1,413,000. The second supposition is that the installation for the first decade is 200,000 and increased as follows: For the second decade, 250,000; for the third, 300,000; for the fourth, 400,000; for the fifth, 500,000; for the sixth, 600,000, and for the last 40 years the full proposed installation of 680,000 hp. The present worth of the payments for this assumed installation is, at the beginning of the lease period, $3,940,000. The third supposition (which is somewhat less than that stated by the power company as the expected installation) assumes 200,000 hp. for the first five years; 250,000 for the second five; 300,000 from the 10th to the 15th year; 400,000 from the 15th to the 20th; 500,000 from the 20th to the 25th; 600,000 from the 25th to the 30th, and for the last 70 years the full installation of 680,000 hp. Upon this assumed installation the present worth at the beginning of the lease period is $5,674,000.

The "present worths" of the fixed payments and of the payments upon installations are to be deducted from the amount to be appropriated by the United States to give the final cost to the United States for the navigation improvement of the 82.5 miles of river. Under the first supposition this final cost would be $7,189,000, under the second $4,662,000 and under the third $2,928,000. The difference between these figures and the $15,701,000 to be appropriated by the United States represents a loan to the power company.

GOVERNMENT ULTIMATELY GETS $20,700,000 WORTH

Under the conditions agreed upon, the power company is to construct, at its own expense, the superstructures of power houses and the transformer stations, but these are to become the property of the United States at the end of the lease. The estimate for these structures, as prepared by the power company, is something over $2,000,000, and the property which the United States will own at the end of the lease period will be that which cost a little more than $20,700,000. In comparison, therefore, with the navigation improvement, costing $8,575,000, the gain in property value to the United States by reason of entering into the co-operative plan of improvement will be $12,125,000. The "present worth" of $12,125,000 at the beginning of the lease period, at the 3-per cent compound rate, is $630,000. Properly speaking this amount also should be deducted, in order to make a true comparison with the cost of the combined and the independent improvements. The power company will have paid from two-thirds to five-sixths of the total cost of property which, at the end of the lease period, will be owned exclusively by the United States.

There must be considered, in connection with the question of to what extent the Alabama Power Company has been favored, that the special board advertised on two occasions, for an aggregate period of more than six months, and received bids from only two parties interested in this development. Not only was the advertisement made in leading technical journals, but circulars of information were sent to all hydroelectric power companies, so far as known, whether or not they made application for information. In spite of the wide publicity only two offers were received, and this is a clear indication of a general lack of interest by hydroelectric companies. The Alabama Power Company has absolutely no control of the situation, and owns only a very small percentage of the lands affected by the proposed dams. There is little doubt that the ability of this company to make a satisfactory offer was due entirely to the proximity of this undeveloped power to the territory in which that company is now distributing electric power.

Futility of Delay

It may be questioned whether or not a delay of several years in the development of the power at Muscle Shoals might result in the securing of a better offer than that now under consideration. If development of the power is delayed for such a purpose, the same reason would justify still further delay in the future, and the logical application of such an argument would result in the power forever remaining undeveloped. The special advantage of accepting the offer of the power company is in the opportunity now to combine this run-of-the-river plant with large storage projects controlled by the power company in northern Alabama, a combination which permits a more complete utilization of the potential power at Muscle Shoals than is possible in any other way. However, even though it be assumed that an equally good combination could be effected ten or more years from now, the delay would postpone to a large extent the industrial development of this section of the country, would cause industries to be established in foreign countries which, with cheap power at the Muscle Shoals, would be located there, and would cause a permanent loss in the coal supply of the country of more than 1,500,000 tons per year.

It is not true conservation of natural resources which forbids their development on the plea that the state or general government is not obtaining full value for the grant of privileges. There is little doubt that franchises for power development should be for limited periods, so that the people may again take over their property and provide for its future operation under conditions suitable to the time when the limited franchise has ended. It is equally certain that the interests of the people demand the regulation of rates to the consumer, so that the company which has been granted the franchise for operating the property belonging to the people may not obtain an undue benefit at the expense of the owners. Assuming such regulation, it is unimportant whether or not any payment is required to be made to the state or general government, or what the size of such payments shall be. In any event, under the assumed regulation of rates, whatever amount is charged to the power company is paid by the consumer, and the collection of such amount is merely an exercise of the taxing power of the government. It seems not unreasonable, therefore, to assume that the present plan, which contemplates navigation improvement of this section of the river and a more complete utilization of the potential power than seems practicable by any other combination of plants, and which can be secured under fair and reasonable terms and at less cost than any other navigation improvement, ought to be adopted, rather than to have this power continue to be wasted for many years and have through navigation remain obstructed by the shoals section, on the ground that delay may result in securing somewhat better terms from some other power company proposing to co-operate.

Shallow Brick Roads

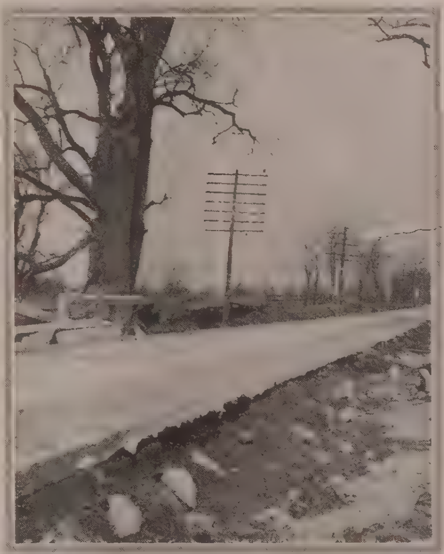
The New York State Highway Department will lay some brick roads this year, using 3 and 3½-in. brick. Both depths will be laid on cement-sand cushions.

Aprons Reduce Flood Damage to Road Shoulders

High Water in Livingston County Teaches Lesson in Protecting Highways in Low-Lying Country

By GEORGE E. SCHAEFER
County Superintendent of Highways,
Geneseo, N. Y.

The recent high water of the Genesee River in Livingston County, N. Y., inundating the major portion of the lowlands and materially damaging some of the newly constructed state and county highways, has caused grave concern among road officials regarding the proper type of construction to be used in such locations, and apparently has shown the necessity of providing additional shoulder protection for roads designated for future improvement. Four state and county improved highways in this county cross the river flats from east to west, and while it is somewhat difficult for a comparison of their original characters of construction in connection with the resultant flood damage they have been analyzed individually as follows:



SHOULDERS ON DOWNSTREAM SIDE OF GENESEO-PIFFARD HIGHWAY, WHERE NOT PROTECTED BY CONCRETE APRONS, WERE WASHED AWAY

The Avon-Caledonia state highway No. 5273, a part of route 6, was completed in 1913. The construction was concrete-bituminous, 6 in. thick, metal 16 ft. wide and roadway 32 ft. between ditches. The crown of the road is about 5 ft. above the flatlands. Since completion there have been but two floods that covered the roadway, damaging only the shoulders on the downstream side. It must be borne in mind, however, that this road is out of the worst run of the current.

The Geneseo-Piffard county highway No. 718, concrete-bituminous construction, 6 in. thick, metal 14 ft. wide, 28 ft. between ditches, was completed in 1913. The average height of the road above the adjoining fields is about 2 ft. Since completion the road has been covered with water six times, the greatest depth above the crown being 4.2 ft. The current, as closely as one could figure, was from 6 to 8 miles per hour. Concrete aprons of the same thickness as the metal section, about 4 ft. wide and sloping with the shoulders, were constructed in the worst known places on the downstream side and on the upstream side where depressions formed a natural channel at time of flood water. Results on the road were that the shoulders on the downstream side, where not protected by the concrete aprons, were washed away entirely, and in some cases holes extended back under the metal. Where protected there was a little wash but it did not jeopardize the pavement. The concrete guard railing was bent over and broken. The bituminous cover was practically all carried away.

The Moscow-Geneseo county highway No. 1247 was constructed of waterbound limestone 3 in. thick on a 5-in. gravel bottom course. The macadam is 16 ft. wide, width of roadway between ditches 32 ft., and date of completion the fall of 1915. Aprons of concrete were built along the shoulders where deemed essential for the preservation of the road. It has been flooded twice since completion, the recent overflow during the latter part of March causing damage estimated at more than $1,000. The top course was almost entirely destroyed, and in a number of locations the whole roadway was washed away to a depth of from 3 to 4 ft. The shoulders were also badly damaged, but more particularly on the downstream side. Again, in this synopsis, it must be seriously considered that this was a newly completed road. Final settlement of the earth had not yet taken place, and there was no growth to speak of on the shoulders.

Mt. Morris-Geneseo Highway

The Mt. Morris-Geneseo county highway No. 622 was completed in 1910 of waterbound macadam 6 in. thick, 14 ft. of limestone pavement and 32 ft. of roadway. The surface of this road is very little higher than the surrounding territory. The road is above the junction of the river and the Canaseraga Creek and, consequently, less susceptible to floods. Damage from high water took place only on the shoulders and was most serious on the downstream side. Soil in the valley is mostly a mixture of clay, treacherous sandy loam and silt. Foundation conditions are poor, the ground being unstable to a depth of more than 40 ft. Large quantities of debris come down the river annually on the crest of the flood and, to a certain extent, form one of the factors causing subsequent damage and deterioration. To build the roads entirely above maximum high water mark would entail an exorbitant expenditure per mile, with a correspondingly greater impediment to a quick runoff and an increased possibility of wash.

It would, therefore, appear that, profiting by past experiences on these highways, with due regard to location, existing conditions and the life of the road, the situation may be summed up in the following manner: Aprons of concrete for the protection of the metal, constructed on the shoulders at the same slope therewith, have conclusively proved their worth, but should be at least 5 ft. wide. The downstream side always sustains the worst damage and should have a suitably adequate and careful design. The grades should be kept at zero, or as nearly zero as possible, in order to allow the water to go over the road uniformly and not in greater volume at some points than others. What are known as evener culverts, where there is no natural channel, have not proved satisfactory. A waterbound type of construction is not fully acceptable. Finally, the surface elevation should be as low as, if not lower than, the adjoining lands, and should not in any way form an obstruction to the natural flow of the flood water.

Small Check Dams, in Series, Lessen Flood Velocities in California Ravines—Part II

Test Results Lead to Prediction That Unit Obstructions Will Be Big Factor in Future Flood Control Plans

By HARRY F. OLMSTED
Of Buck & Olmsted, Conservation Engineers, Los Angeles

[In the first part of this article, published last week, Mr. Olmsted discusses Southern California flood flows and the history of investigations to prevent them. Check dams were proposed as a remedy and experiments were carried out to test their efficiency. In this week's issue the actual results of placing unit obstructions in ravines are given in detail.—Editor.]

THE experiment station with its 24-ft. dam on Clear Creek, described last week, was under the direct personal supervision of B. R. Metcalf, who is preparing an elaborate analysis of the results achieved. His curves will make it possible to determine approximately the character and number of the structures in any given watershed, after controlling grades and drainage areas are known.

400 CHECK DAMS BUILT

The remaining $10,000 of the $23,000 appropriated for experimental work was spent in constructing about 400 check dams in Haines Canyon, a small torrential stream discharging into the Tujunga River. This canyon was chosen for the following reasons: First, the watershed had been entirely denuded by fire in the summer of 1913, and its barren slopes promised a convincing test of the Swiss system. Second, measurements taken after the disastrous flood of 1914 indicated that the 712 sec.-ft. per square mile of area discharged from Haines Canyon was the maximum unit flow ever recorded in Southern California. Third, inasmuch as two separate communities and much valuable acreage were menaced by this torrent, any beneficial results attained by the experimental work in this canyon would have the added value of giving practical relief to this district. Fourth, any object lesson observed as a result of treating the 1000-acre Haines watershed could be taken as a safe working basis for similar operations throughout Southern California.

The first expenditure in the Haines watershed was made under the direct supervision of C. C. Buck, an experienced superintendent of construction, who has built similar structures in Alaska to protect sluicing operations. This work was done in December, 1914, and consisted in building six retarding dams in a dry ravine called Western Empire Canyon, which discharges into Haines Canyon, 2 miles above its mouth. The materials used in this construction were granite boulders and oak logs which were found on the hillsides directly above each dam.

POOLS FORMED BY CHECK DAMS INDUCE GROWTH OF VEGETATION

FIRST TEST BY STORM

The first test given these structures was in the major storm of January, 1915. A rain gage situated in the valley 3 miles below showed 9 in. for the storm, and during a certain 1½ hr. the precipitation measured 1 in.

The writer was in Haines Canyon during the height of this storm, observing run-off condition. While all little side gullies and ravines were pouring out their flood of turbid water, the treated ravine above referred to had no surface flow escaping into Haines Canyon over the face of the detrital cone. Within the treated canyon the water was flowing clear and was being entirely absorbed in the gravels at the mouth. This condition was maintained during each storm throughout the winter. During the following summer Western Empire Canyon was observed to have undergone a radical change. Instead of a perfectly dry and barren gash in the burnt-over mountain face, the bed of the gully was filled with moisture. Willows were springing up everywhere and in one place the writer measured 1/6 in. of water flowing. These conditions had been attained in a gulch where neither summer flow nor willow growth had ever been seen. E. J. Mehren, editor of the Engineering Record, inspected the work in September, 1915. He noted with surprise the abundant vegetation springing up in the bed of the ravine within the zone of moisture.

RUNOFF CONDITIONS ON THREE MOUNTAIN WATERSHEDS, SHOWING EFFECT OF CHECK DAMS

Mountain Watershed	Sq. miles area	Max. disch., Jan., 1916, sec.-ft.	Max. disch. per sq. mile, sec.-ft.	Surface flow at mouth of canyon, Feb. 20, '16, sec.-ft.	Surface flow at mouth of canyon per sq. mile, sec.-ft.	Per cent of column 4 of average of 3	Per cent of column 6 of average of 3
1.	2.	3.	4.	5.	6.	7.	8.
Haines	1.45	164.5	113.4	1.008	0.696	42.3	113.9
Cook's	.50	269.5	539.0	0.24	0.480	201.1	78.5
Little Tujunga	18.70	2,835.0	151.60	12.3	0.658	56.6	107.6

The work was carried rapidly forward in Haines Canyon until the fall of 1915, at which time it was discontinued by the board of engineers, who considered that enough had been done to determine what degree of efficiency this class of construction might accomplish. At the beginning of the rainy season Haines Canyon became the central point of interest for those in Southern California who were concerned with flood problems.

RAINFALL RECORDS

No storms of any importance for the season were recorded in Southern California before Jan. 1, 1916. On that date, however, rainfall started, and with the exception of Jan. 3, 7, 11 and 12, more or less rain fell during each 24 hr. until Jan. 19. In this 16 days' rainfall the Pasadena gage situated at the foot of the San Gabriel Mountains showed 12.96 in. with 7.90 in. concentrated on Jan. 17, 18 and 19. The greatest rainfall for any 24-hr. period was between 6 p. m., Jan. 16, and 6 p. m., Jan. 17, when 4.68 in. fell. The greatest hourly intensities occurred between the hours of 3 a. m. and 6 a. m. on Jan. 17, during which time 2.01 in. fell.

The precipitation for the 24 hr., Jan. 16 and 17, was 5.71 in. in Haines Canyon against 4.16 in. in Los Angeles, and 5.31 in. in Pasadena. Equating the ratio of hourly intensities to total precipitation in Haines Canyon to that of Pasadena and Los Angeles in turn we obtain two sets of values for the hourly intensities in Haines Canyon. Averaging these it would appear that 68.2 per cent of the rainfall for the 24 hr. fell in eight consecutive hours, and that 41.5 per cent fell in three consecutive hours, and that 16.8 per cent fell in one hour. At the end of

RAINFALL, IN INCHES, DURING STORM, JAN. 17, 1916

Time, A. M.

Gage	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
Los Angeles	.17	.30	.56	.83	.60	.19	.11	.16	.08	.01	.02	T
Pasadena	.15	.29	.49	.73	.65	.66	.23	.34	.61	.04	.02	.03
Probable Haines Canyon: Prec. Basis L. A. Gage	.23	.41	.77	1.14	.83	.26	.15	.22	.11	.01	.03	T
Probable Haines Canyon: Prec. Basis Pasa. Gage	.16	.31	.53	.78	.70	.71	.25	.36	.12	.04	.02	.03
Haines Canyon Average	.19	.36	.65	.96	.76	.48	.20	.29	.12	.03	.02	.02

Time, P. M.

Gage	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	Total for 24 hr.
Los Angeles	.12	.09	.02	.03	.08	.11	.10	.06	.09	.17	.16	.10	4.16
Pasadena	.07	.03	.01	.07	.10	.17	.22	.10	.09	.20	.21	.32	5.33
Probable Haines Canyon: Prec. Basis L. A. Gage	.16	.12	.03	.04	.11	.15	.14	.08	.12	.23	.22	.14	5.71
Probable Haines Canyon: Prec. Basis Pasa. Gage	.08	.03	.01	.08	.11	.18	.24	.11	.10	.21	.22	.34	5.71
Haines Canyon Average	.12	.07	.02	.06	.11	.17	.19	.10	.11	.22	.22	.24	5.71

this eight hours of intense rainfall there were 15 cu. ft. per second being discharged from Haines Canyon at 7.30 p. m., and there was no evidence that more than 25 cu. ft. per second had passed at any time. Furthermore the velocities of flow during the peak of flood discharge were so low that the succulent young growth with which the stream bed was filled was not harmed to the slightest extent.

CHECK DAMS PROVE VALUE

At 11 p. m., Jan. 17, the writer, with others, inspected the Sunland wash or Lower Haines Channel, where it is crossed by Walnut Avenue, Sunland. It was at this point that the water left the debris-filled channel in 1914, and practically ruined seven acres of fine land, belonging to Secretary Wells of the Sunland Chamber of Commerce. The channel at this point was without surface flow and the writer estimated from water marks that the maximum flow during the night had not exceeded 10 sec.-ft. Mr. Wells said, "In my five years' residence here I have seen but one worse storm, that of February, 1914. At least once every year, and sometimes twice a year, it would have been foolhardy to attempt to cross the Sunland Wash with an automobile. This year any agile person could have jumped over it in its highest stage."

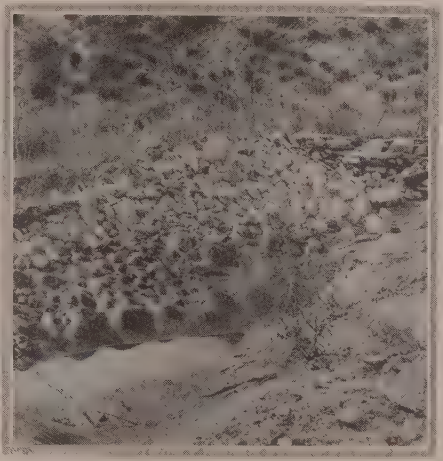
Mr. Rowley, who has resided in Sunland for thirty-three years, said, "I arose at 2 a. m., Jan. 17, because I expected trouble as a result of the intense rainfall at this time. A small creek discharging through the town of Sunland was carrying a large quantity of water and was doing more damage than ever before. The Sunland Wash, which drains Haines Canyon, was barely running, and despite the fact that the heavy rainfall continued for over three hours, a man could have crossed the wash on foot anywhere."

At 12 o'clock noon Haines Canyon was discharging 5.05 sec.-ft. at its mouth. This water was perfectly clear and had a velocity of 2 ft. per second. At 12.30 p. m., Fall Canyon, Laurel Canyon and Upper Haines Canyon, the three principal tributaries of Haines Canyon, were discharging 1.6 sec.-ft., 0.75 sec.-ft. and 0.60 sec.-ft., respectively, and excepting Fall Canyon which had run probably 15 sec.-ft., they were at the maximum discharge for the storm.

CHECK DAMS HAVE PREVENTED FLOW FROM PASSING OVER THIS LARGE CONE OF DEPOSIT AT MOUTH OF WESTERN EMPIRE RAVINE

HAINES CANYON WAS DENUDED BY FIRE IN 1913 AND THERE WAS LITTLE VEGETATION LEFT TO RETARD THE WATERS IN THEIR WILD SWEEP TO THE MONTE VISTA VALLEY

It must be borne in mind for the sake of comparison that at 12 o'clock noon, Jan. 17, the principal streams of Los Angeles County were in full flood flow. They had passed the danger point and were tearing out bridge approaches, carving new channels, etc. The Tujunga River, into which Haines Canyon discharges, had just ruined a Los Angeles County protection levee that had been constructed at great cost less than a year before. It also had broken through the Southern Pacific Railroad Company's levee north of the San Fernando Boulevard and was menacing hundreds of acres of valuable property.


VERY SMALL AMOUNTS OF SILT ARE CARRIED INTO THE BAYS BEHIND THE AVERAGE CHECK DAM

COMPARISON OF FLOW CURVES

A comparison of the flow curves of Haines Canyon, Cook's Canyon, and Little Tujunga River, practically adjacent watersheds, is indicative of what may be accomplished by check dams. It is indeed gratifying to see that Haines Canyon, which, in 1914, discharged the maximum unit flow ever recorded in Southern California, is to-day showing a flatter curve than either of its two neighboring streams.

From experiments in Clear Creek and from one season's test of the main Haines Canyon and a two years' test of Western Empire Ravine, we are in possession of the following data:

Twenty structures at the experiment station in Clear Creek reduced the velocity of flood flow as much as 71 per cent, demonstrating the stability of inexpensive structures when checking high flood velocities.

That the flood flows in Haines Canyon have been changed from much the worst of any in the immediate neighborhood to by far the best, is indicated by the first test given these structures.

That out of Western Empire Ravine, with a large cone of deposit at its mouth, there has been for two seasons no surface flow into Haines Canyon, and a constant summer stream in this canyon has been developed where none had ever been observed before.

These facts are of sufficient weight, I believe, to warrant the engineering opinion that check dam construction is valuable as a flood preventive measure, and that it will come to be recognized as one of the important factors in controlling floods, not alone in Southern California, but in the headwaters of the Ohio, Mississippi and Colorado River systems.

Expense Limits, Pennsylvania Highway Department

FOR some time, states William R. Main, auditor of the Pennsylvania State Highway Department, in the "Pennsylvania Highway News," the department hesitated to place arbitrary restrictions on the amount allowed a man for subsistence in the field, each account being scrutinized carefully on the basis of its individual merit, the fact being taken into consideration that rates for the same service varied widely in different parts of the state. The general rule was that an individual should incur no greater expense in connection with state highway department work than if he were traveling on his own account. It became apparent, however, that the temptation was toward extravagance and due care was not taken to get service at the most reasonable rates possible.

As an offset, therefore, arbitrary rules were established and are now in force, limiting the charge to engineers, superintendents and corps men for single meals to 50 cents and the combined charge for one day's board and lodging to $2. No Pullman charges are allowed except sleeping car service and this only when accompanied by letter of explanation. The chief of party is held responsible for making arrangements in advance for his corps at farmhouses and boarding houses in preference to having the men avail themselves of hotels in adjacent towns at a greatly increased expense. At no time is a man permitted expense outside his own district unless so ordered by the chief engineer.

Railroad Bridge Piers Built Both Ways from Central Plant on Island

Four-Rail Trestle at Milton, Pa., Accommodates Cranes on Center Track and Concrete Trains on Outside Tracks—Two Sets of Forms Build Twelve Piers

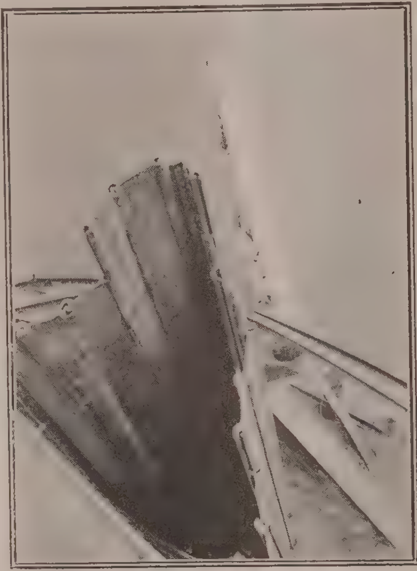
USING a central construction plant on an island and transporting concrete and materials both ways on a trestle upstream from the work, the twelve concrete piers and four abutments for the new Philadelphia & Reading Railway bridge over the Susquehanna River at Milton, Pa., have been practically completed since a contract for them was let last July. The work was carried on through a severe winter, as a climax to which the flood on which the winter ice went out early in April carried away the entire construction trestle across the east channel and destroyed the partly built steel cofferdam for pier 3. The trestles used were unusual in providing three tracks with four rails—one for locomotive cranes and two for concrete—while the work was handled so that all three tracks were used at once.

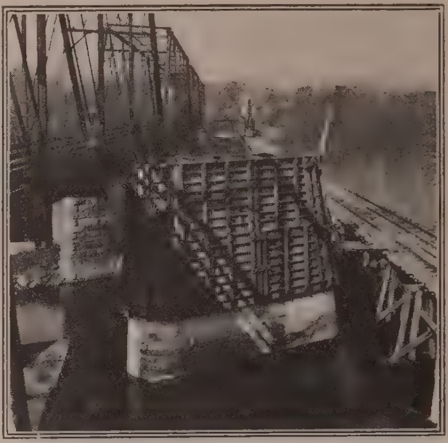
GRADE CROSSINGS TO BE ELIMINATED

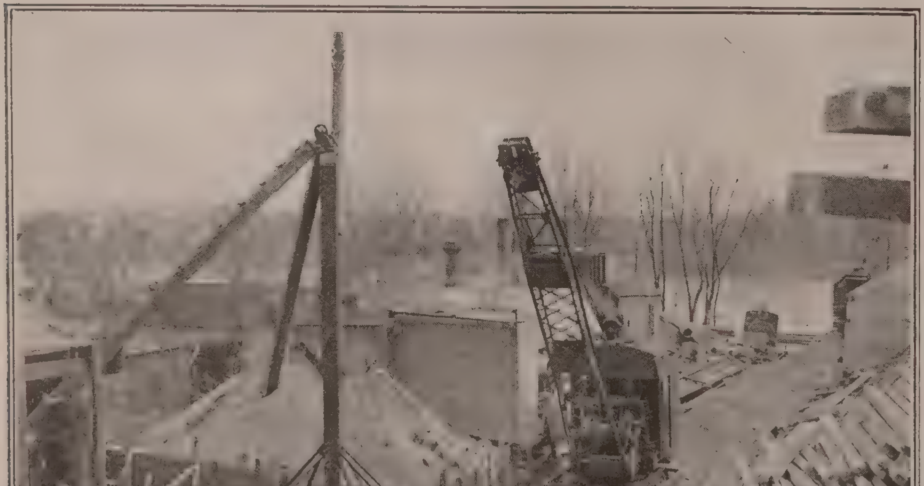
The new bridge, immediately upstream from and 5 ft. higher than the old, will make possible the elimination of street grade crossings in Milton. This work is now going forward under a separate contract, and the line will be raised when it is finished so that it will not be difficult later to eliminate the grade crossing at the Pennsylvania Railroad east of the present improvement work.

The river has a shale bottom from 10 to 16 ft. below low water, covered with from a few inches to 8 ft. of silt and gravel. Piers were therefore easily built. By using through girder spans and raising the elevation of the track, it was possible to provide the same waterway that existed with the old bridge, to keep the steelwork above the highest flood level and to lower the cost of construction as compared with longer spans. The crossing is for the Catawissa branch of the Philadelphia & Reading Railway, which joins the main line just west of the bridge, and both the old and new bridges are single track.

Both old and new bridges are made up of two independent bridges across the east and west channels connected by a short fill across the island. A turnout on trestle work from the old line was built on this island for delivering material. Bottom-dump sand and gravel railway cars were dumped from it to a storage pile below and upstream from the trestle. At the foot of this pile was the track extension of the two construction trestles, north of which in turn were two mixers mounted under separate hoppers. One was fed by a guy derrick and the other by a stiffleg derrick. The cement was also handled by these derricks in skips. Crossovers on either side of the mixers between the narrow-gage tracks, which were the outside ones, allowed all the switching to be done at the mixers. The crane when dumping concrete was thus always busy, being supplied by two tracks. Gasoline mine locomotives did the hauling, and are preferred by the contractor to steam dinkies.


FORCE OF ICE JAM BENT 18-INCH BEAMS


END FORMS TIED ON WITH WIRE ROPE


TWO MIXING PLANTS FACED TRACK CONNECTING TRESTLES ACROSS ISLAND

The stiffleg derrick is between the two plants, the guy derrick being to the left of the photograph and unloading trestle and material piles to the right.

SINGLE-WALL STEEL COFFERDAMS

The steel coffers, about 20 by 40 ft. with round ends, were set between inside and outside frames. The sheeting was driven through the mud and slightly into the shale, which is soft enough to pick, to shut off leaks at the bottom. An 8-in. pump, set in the upstream end, unwatered each dam. As the water was lowered two or three sets of bracing were put in and the mud removed by hand digging with buckets and dumped around the piers. A sump was cut in the rock in each case and shallow side ditches picked out to drain the rock surface inside the footing form.

TWO SETS OF FORMS REQUIRED

The work was started at the island and carried across the west channel first. The advance locomotive crane drove the trestle, which consisted of 18-in. I-beam stringers on capped bents of five piles each, and also set, drove and excavated the coffers. The second crane followed it up with the concrete work. Two sets of pier forms of four build-ups each kept three piers going at a time. By the time the first pier was ready for the last lift the second pier would be above water, and the bottom forms would be stripped from the first pier and set up at the third. These forms were of 1-in. tongue-and-groove lumber on vertical studs, lined with sheet steel plates. The side forms were tied through with rods and the curved end forms held on by ⅜-in. cables with turnbuckles, passing entirely around the pier.

Enough steel sheeting, from 20 to 28 ft. long, was required to build one abutment and four pier cofferdams at the same time.

MORTAR FACE USED

The piers and abutments were faced with "granolithic" inside the form, using vertical steel plates which overlapped and extended all around the form. These were raised as concreting progressed. Molding strips, tacked on through nail holes in the steel form plates, were used to make band courses around the piers. The "granolithic" mixture was made at the pier being concreted either by hand or in a small wheeled mixer set on a plank platform on the trestle. Sand and cement were sent out to it on cars in the concrete trains.

On the completion of work in the west channel that in the east channel was started and handled in the same way, except for the

WORK IN WEST CHANNEL FINISHED FIRST

interference from floods mentioned, and except that a mixer and derrick were set up on the east shore to build the abutment on that site. This was wanted in advance to allow the track fill to be made against it. At the time of the April flood the coffer for the fourth pier from the island had been partly stood up but not driven. It collapsed in the ice jam, which was under such pressure as to curl several of the trestle stringers around the pier noses as if they had been old rails. The trestle was replaced as rapidly as possible to the fifth pier from the island, which was built in advance of the fourth while the contractor was waiting for a lower stage of water to remove the wrecked cofferdam.

The old piers will be removed but the old abutments have been capped with concrete and will serve as downstream wing walls for the new ones.

The pier work was done for the Philadelphia & Reading Railway by the Robert Grace Contracting Company, for which F. P. Kemon was superintendent under B. R. Hundley, manager of the contractor's work in the Eastern territory. S. T. Wagner is chief engineer and Clark Dillenbeck engineer of bridges and buildings of the Philadelphia & Reading Railway, while the field work was in the immediate charge of J. S. Ward and E. F. Gorman, successively resident engineer.

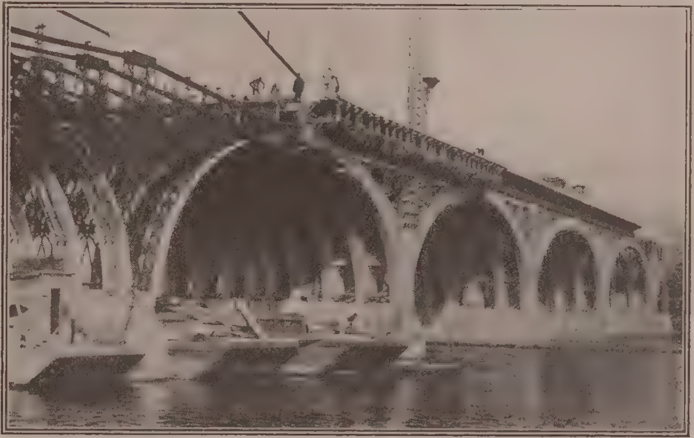
Eliminating Grade Crossings

Of the thirty-six grade crossings on a 210-mile stretch of the California state highway near the Oregon line, thirty have recently been eliminated by relocating the highways.

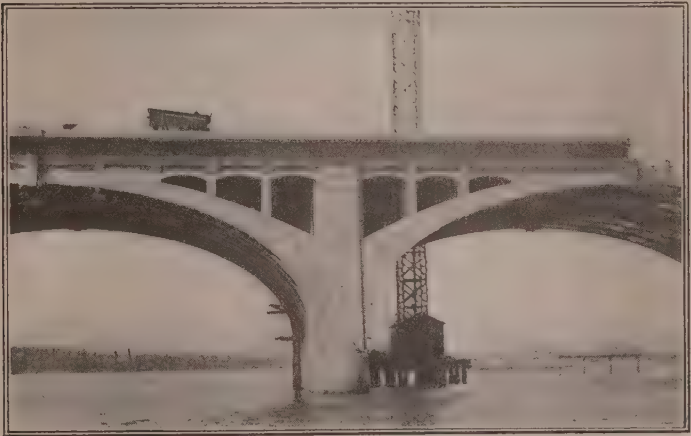
Steel Cantilever Ribs Balanced Over Main Piers to Form Arched Concrete Spans

Hanover Street Bridge Over Middle Branch of Patapsco River, Baltimore, Designed to Avoid the Use of Falsework—Unusual Pier and Abutment Details Adopted

UTILIZING the cantilever principle in the design of the structural steel ribs in the main arched spans, in order to facilitate the erection by placing the fabricated units over the piers and using them for the support of the concrete forms, the necessity for expensive falsework or centering in the construction of the long highway bridge at Hanover Street, Baltimore, Md., described in last week's issue, page 632, was entirely avoided. Arch action in the arched steel ribs of the main spans is eliminated, since the only connection between the adjacent cantilevers at the crown is a 3-in. pin placed longitudinally to transfer any unbalanced live load for conditions causing unequal deflection.



→ VARIOUS STAGES IN THE CONSTRUCTION OF MAIN SPANS

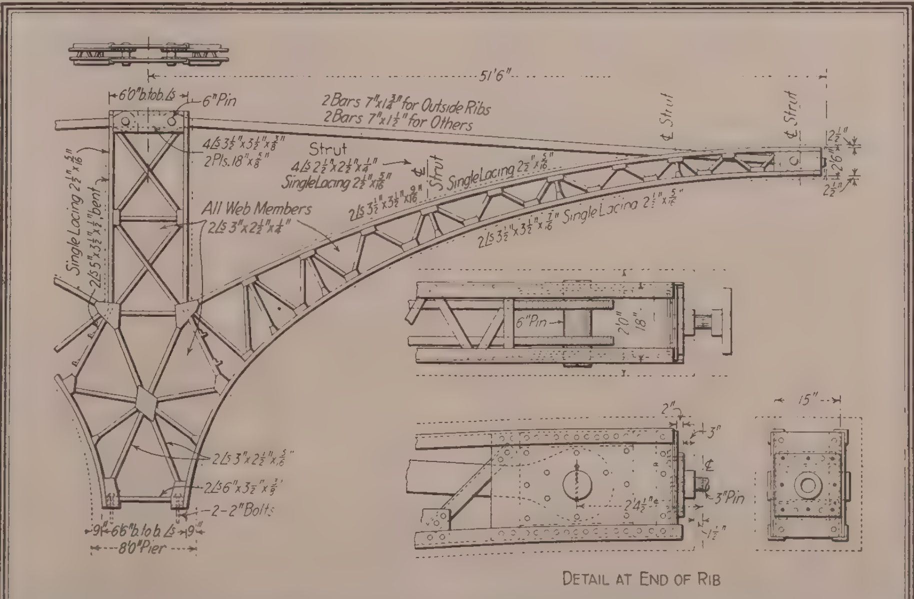


← PIER 2 WITH FORMS REMOVED — CONCRETE TO BE RUBBED

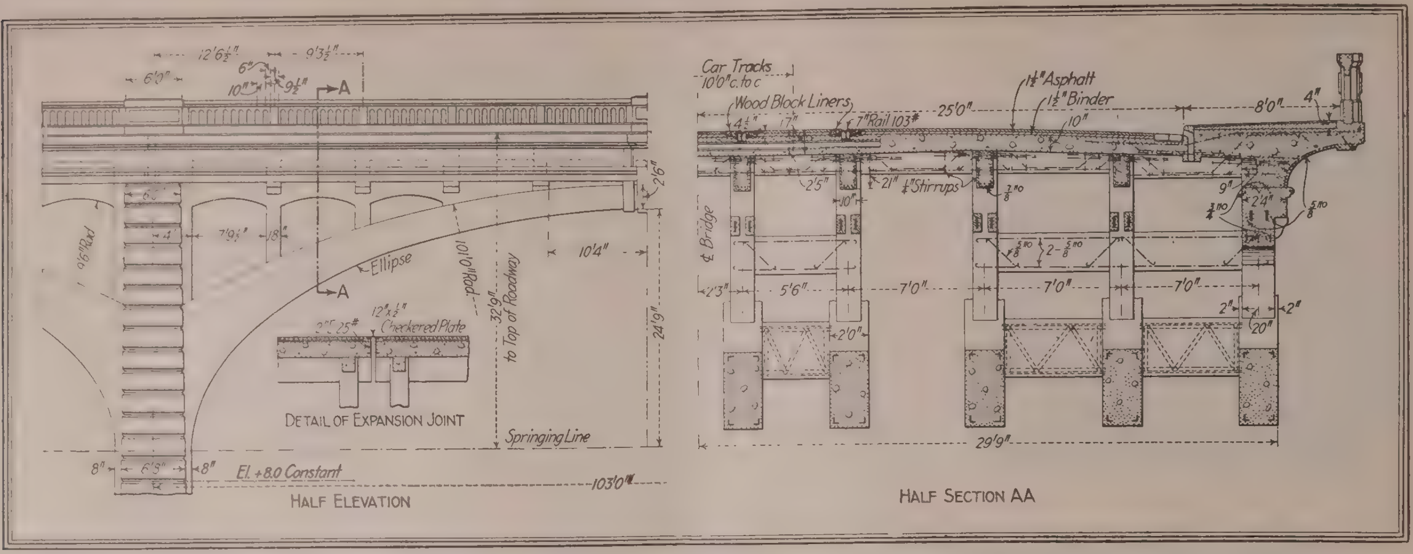
The main piers were designed with vertical reinforced-concrete cross walls, so that the amount of concrete used was considerably reduced. Another special construction is the south abutment, formed of curtain walls offset and paneled on the outside, hiding the cantilever ribs extended backward symmetrically to balance the cantilever arm of the south main span. Similar construction exists at the pier joining the arcade section and the main arched section, and also at the bascule piers, except that the cantilever arms are not symmetrical.

GENERAL DESIGN FEATURES

The Hanover Street bridge, now under construction for the Maryland State Roads Commission, is to replace the existing Light Street timber viaduct crossing the Patapsco River between Baltimore and the village of Brooklyn in Anne Arundel County, Md. The new bridge, however, is located on an entirely different line. It crosses the middle branch of the river nearly perpendicularly by the main arched spans here described, passes over the point of land in Baltimore County by a deep cut for a distance of 1900 ft. and thence by a fill in shallow water for 1400 ft. to a bridge consisting of sixteen 30-ft. and one 32-ft. continuous reinforced-



STEEL RIB DETAILS—CROWN JOINT PIN TRANSFERS UNBALANCED LOADING TO ADJACENT CANTILEVERS

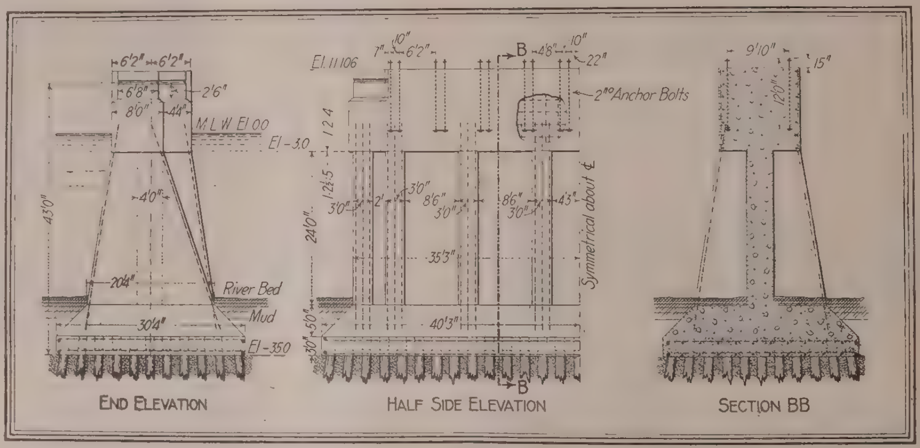


HALF ELEVATION AND SECTION OF TYPICAL SPAN WITH ELLIPTICAL INTRADOS FOR CONCRETE RIBS TO IMPROVE APPEARANCE

concrete spans, then by 1600 ft. of shallow fill to a bridge of seven 15-ft. continuous spans to Brooklyn.

The principal crossing, nearly 2300 ft. long, consists of twelve main arched spans of 103 ft. between centers of piers, with a rise of 25 ft., a double-leaf bascule span of the Rall type, 150 ft. clear, with two adjacent 55-ft. spans masked with curtain walls and supporting the operating house, 460 ft. of small arched-beam construction called the arcade, with curved longitudinal and transverse outlines, and 210 ft. of counterforted retaining wall connected with ties on the north approach leading from Hanover Street. The main span lengths and clearances were fixed by the government requirements for allowing small boats to pass without the necessity for lifting the bascule span. The new grade is some 30 ft. above that of the old viaduct.

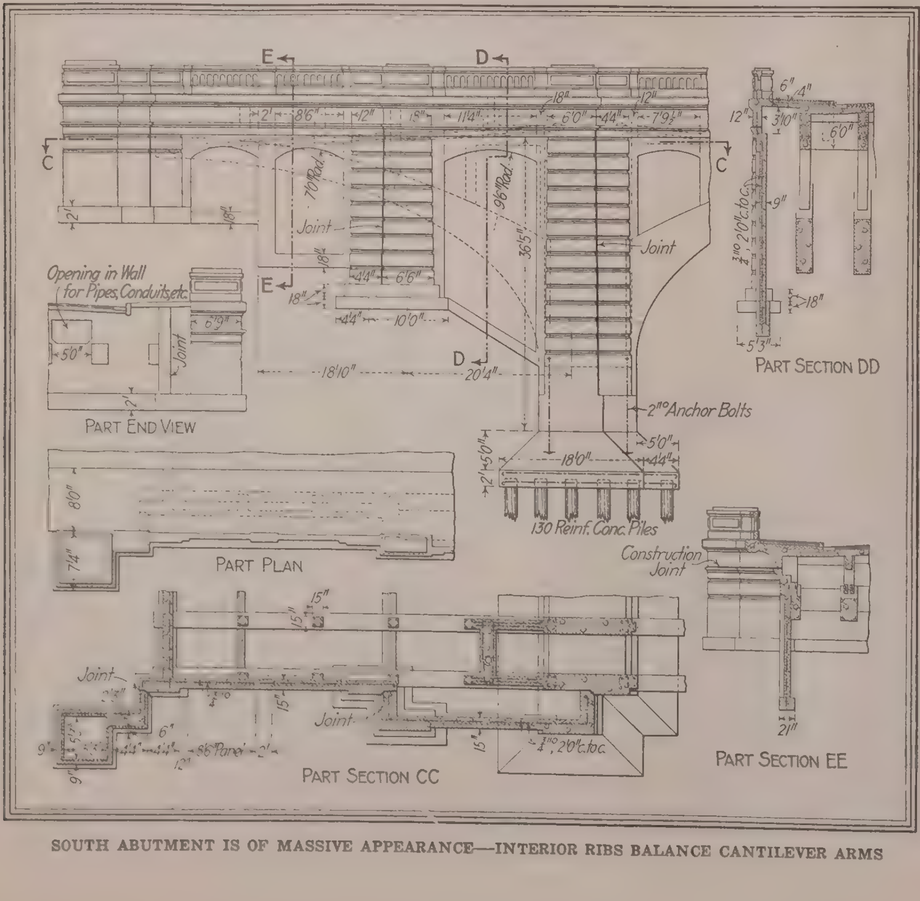
The accompanying drawing shows the typical construction of the main arched spans. The floor is a concrete slab reinforced in both directions, using ⅝-in. round rods on 5-in. centers transversely and 8-in. centers longitudinally, with the spacing increased toward the supports and alternate rods bent up over the supporting beams. Rods 5 ft. long are added at the top flanges over the beams to aid in resisting negative bending moments. An expansion joint is placed at the center of each main span, with details as shown in the drawing herewith. Similar joints are placed about 106 ft. apart on the arcade approach section of the bridge.



MAIN PIERS DESIGNED WITH CAP AND BASE CONNECTED BY VERTICAL WALLS

DESIGN OF MAIN RIBS

The cantilever steel framework shown in an accompanying drawing, consisting of eye-bar top chords, a vertical tower and arched girder lower chords, ten over each main pier, was designed to carry the wet concrete as it was poured and the forms necessary to support this concrete, assuming that the two cantilever ends would be poured nearly symmetrically. Then the reinforced concrete arms were analyzed for full and unbalanced live load, assuming that an initial stress had been developed in the steel by the forms of green concrete. The method of least work was used to analyze the stresses in the cantilever arms to obtain the shear transferred to the adjacent arm by the crown pin. For the live load analysis the strengthening effect of the inclosing concrete in resisting compression was included by finding a pressure line and treating the entire rib as a reinforced concrete arch ring, the value of concrete being taken as 650 lb. per square inch. Only a slight unbalanced dead load was provided



SOUTH ABUTMENT IS OF MASSIVE APPEARANCE—INTERIOR RIBS BALANCE CANTILEVER ARMS for in the design of the vertical steel tower and its anchorage to the pier.

The live loading used in the design consisted of two 50-ton electric cars, coupled together, on each railway track, a 24-ton truck on any part of the roadway, and 80 lb. per square foot on the sidewalk. To provide for impact effects, the live load stresses due to moving wheel loads were increased 15 per cent. The lateral forces prescribed were 30 lb. per square foot on one and one-half times the area of the vertical projection and 10 per cent of the specified live load on one track. The longitudinal forces were specified at 20 per cent of the live load for one line of traffic.

The vertical spandrel columns supporting the roadway floorbeams were first designed as reinforced-concrete columns with vertical round rod reinforcement. At the request of the fabricating company an alternate design, using four angles 2 x 2 x ¼ in. with tie plates, inclosed in concrete, was adopted in order to make the units complete for erection purposes, to give stiff connections between the main lower rib and the columns and to furnish support for the eyebars.

MAIN PIERS AND SOUTH ABUTMENT

As indicated by an accompanying drawing, the main piers are designed to economize in the amount of concrete by the use of vertical cross walls, which resemble a reinforced-concrete counterfort type of construction. The steel rods are all placed near the outside of the 3-ft. cross walls where they are most effective in developing the required fixing moment for unbalanced loading on the cantilever arms.

The apparently massive construction at the south abutment pier 1 and at the bascule piers is attained by the use of reinforced-concrete facing walls, with deep panels and wide offsets, masking the balancing ribs which extend into them. The end retaining wall at the south abutment is simply a connecting transverse wall joining the outer walls and the ribs, and made deep enough to reach a secure foundation, widened with a footing. The cross walls at pier 1 and at the bascule piers act as counterweights necessitated by the short ends of the hidden cantilevers.

The structure is being built under the supervision of H. G. Shirley, chief engineer of the Maryland State Roads Commission. J. E. Greiner of Baltimore, is consulting engineer, and E. H. Wroe, district engineer. The general contractor is H. P. Converse & Company of Boston, Mass. The steel framework for the main structure was fabricated by the Maryland Steel Company, and the Strobel Steel Construction Company designed and erected the bascule span.

Consistency Test for Concrete

The structural materials testing laboratory of Lewis Institute, Chicago, under Prof. D. A. Abrams, is conducting some tests for the committee on aggregates of the American Society for Testing Materials on a method of standardizing the consistency of mix of concrete. Cylindrical forms 8 in. in diameter and either 12 or 16 in. high are used. The concrete is poured in them and puddled with a bar. The form is removed at once. If the mixture stands without change it is considered too dry. If it slumps more than a ¼ in. it is too wet. If the slump is only ¼ in. it is considered correct. Final conclusions have not been reached regarding the test.

Products Depending on Hydroelectric Energy

Affect Greater Number of Industries Than Is Generally Appreciated—Lawrence Addicks Gives, Also, Unit Power Consumption

BRIEF reference was made in this journal last week in the editorial entitled "The Waste at Niagara," to the industries dependent on electrically-produced products. This subject was enlarged upon by Lawrence Addicks, past president of the American Electro-chemical Society, in an address on April 26 before the American Institute of Electrical Engineers. Mr. Addicks also discussed cost of power in relation to electrochemical processes. This phase of the subject is discussed editorially in this issue, but the present extract from the paper refers only to the materials produced and the unit power consumptions.

The electric current, Mr. Addicks said, may be used for its chemical effect, giving oxidation products at the anode and reduction products at the cathode in an electrolytic cell; or it may be used for its heat effect in an electric furnace, where high temperatures and a controlled atmosphere are desirable; or both effects may be utilized, as in the electrolysis of fused salts. Finally, we have the effects of electric discharges through gases.

A small beginning in electro-plating two generations ago has developed until the great majority of the copper output of the world is electrolytically refined; silver is thus parted from gold and gold from the platinum metals, bismuth-bearing lead can be successfully treated, electrolytic nickel is well known, and zinc and tin so refined are appearing in the market. In general, electrolytic refining not only increases the purity of the metal but makes possible the recovery of the impurities as byproducts. thus greatly cheapening the cost of some of the less common elements.

The electrolysis of common salt is the basis of the electrolytic alkali industry, the products of which are caustic soda, the starting point for various chemical industries, and used in very large quantities in soap making, mercerizing cotton, etc.; metallic sodium, also used as a foundation for other products, such as the cyanide so largely used in the metallurgy of silver and gold; chlorates, used in the manufacture of matches, certain explosives, etc.; hypochlorites, of value for bleaching; chlorine, employed as a sterilizing and chloridizing agent and for the formation of bleach.

ELECTRIC FURNACE

The electric furnace has created a host of new industries. Very briefly, the chief products consist of abrasives, such as carborundum, alundum, aloxite, etc.; graphite; silicon; ferro-alloys, such as ferro-silicon, -manganese, -chrome, -tungsten, -vanadium and others, which are used in the steel industry for producing sound ingots, hardening, making special steels, high-speed tool steel, armor plate, etc.; refined steel of crucible grade; phosphorous by distillation; calcium carbide, used in the generation of acetylene and in the manufacture of cyanimid; and so on. It is also being tried out experimentally as a competitor of the combustion furnace in the metallurgy of many metals. Used as an electrolytic furnace, we have the very important application to the production of aluminum.

The industrial use of electric discharges through gases is still in its infancy, but we have ozone and nitric acid among the products, the former used for sterilization and the latter as a base for fertilizers and explosives.

Every one of these industries consumes large quantities of energy. Starting at the bottom, we have the refining of lead at 120 kw.-hr. per ton. and of copper at 300 kw.-hr. per ton. Where diaphragms are used, as in nickel refining, the power rises to about 3000 kw.-hr. per ton. Where insoluble anodes are used for the recovery of a metal from solution, the power will range from 700 to 4000 kw.hr. per ton, depending upon the metal, the amount of depolarization at the anode, and of course the current density.

Turning now to electric furnaces, an ordinary melting operation, such as casting an alloy or refined steel, generall requires from 600 to 1000 kw.-hr. per ton. In the production of ferro-alloys, which is really a smelting operation, a large amount of energy is consumed by the endothermic reaction, and the power used runs from 3000 to 8000 kw.-hr. per ton of product, depending upon the grade of alloy made. The aluminum furnace requires 25,000 kw.-hr. per ton of product. The electrolytic refining, alkali and aluminum industries require direct current; the graphite, carborundum, melting and ferro-alloy furnaces use alternating current. In general low voltage and high amperage is employed. In the case of alternating current this is readily obtained by the use of suitable transforming units; in the direct-current processes it is customary to connect a sufficient number of cells or furnaces together to obtain a reasonable line voltage. Individual industries in plants of modern commercial size require blocks of energy ranging from 5000 to 50,000 kw.-hr. and it is self-evident that the charge for energy in such quantities is a vital item.

Hydroelectric Power in Spain

ACCORDING to recently compiled statistics, U. S. Consul General Hurst, at Barcelona, reports the hydraulic power available in Spain is estimated at over 5,000,000 hp. There are 110 large hydroelectric plants exploiting a total power of 281,490 hp. and a large number of small plants, so that the whole amount of power in use may be reasonably estimated at 300,000 hp. This total will probably be increased to 500,000 during 1916, when important installations are expected to be completed. The total horsepower controlled by the 110 large enterprises referred to is 1,020,790, and consequently 739,300 of their total power remains to be developed.

Independent of this amount numerous paper, spinning, and flour mills, and other manufacturing plants are run by water power not transformed into electricity. In Catalonia, northeastern Spain, the textile industries alone use some 200,000 hp., about one-half of which is natural water power. The estimated power of the streams of the Pyrenees running through Catalonia amounts to 1,135,000 hp., and concessions have been granted for the exploitation of only 800,000 hp.

The water power of the rivers of Spain has been estimated as capable of producing horsepower as follows: Ebro and affluents, 1,300,000; Duero, 900,000; Guadalquiver, 750,000; Tajo, 700,000; Guadiana, 370,000; Miño, 250,000; Jucar, 190,000; Segura and affluents, 100,000; and others, 600,000, making a total of 5,160,000 hp.

Truss Deflections Accurately Determined by Angle Changes and Elastic Weights

Different Methods Explained and Compared—Practical Formulas and Diagrams Designed to Save Time Are Illustrated by Examples—Part 2

By D. B. STEINMAN
Special Assistant to Gustav Lundenthal, Consulting Engineer, New York City

CONTINUING the discussion of the method of angle changes and its applications, as presented in Part 1 in last week's issue, page 644, the example of change in length of an arch chord will now be considered. The method of elastic weights will then be presented in full detail and followed by examples of its application.

EXAMPLE 6—TO FIND THE CHANGE IN LENGTH OF AN ARCH CHORD

In this case the "weights" $\Delta\varphi$, instead of being applied vertically, are considered acting in the direction of the desired deflection; that is, parallel to the arch chord AB, Fig. 12. The deflection due to the angle changes will be the sum of the moments of the angle changes about AB.

$$\Delta l = \Sigma y \cdot \Delta\varphi \qquad (9)$$

where y is the perpendicular distance of each angle change from the chord AB. To correct for the line changes, the formula becomes

$$\Delta l = \Sigma y \cdot \Delta\varphi + \Sigma \Delta s \cdot \cos \alpha \qquad (10)$$

where Δs is the elongation of each member of the linear chain and α is its inclination to the chord. If the panel length p is constant, this formula may be written

$$\Delta l = \Sigma y \cdot \Delta\varphi + \frac{p}{E} \Sigma u \qquad (10a)$$

where u is the unit stress in each member.

The value of Δl thus found for any given loading, divided by the value of Δl for a horizontal unit load applied at B, will give the horizontal reaction H at the ends of the arch if the displacement is prevented. In a three-hinged arch the value of Δl given by equation (10) or (10a) divided by the arch rise will give the angle change at the crown hinge. Formula (10) may also be applied to find the change in distance between any two points of a curved chord of an arch or truss.

DEFLECTION DIAGRAMS FOR HIGHER STRUCTURES

To find the vertical deflections of the arch represented in Fig. 12, the moment diagram of the angle changes is constructed as for a simple span AB. In other words, after the strains Δs are found, the indeterminateness of the structure does not affect the calculation of the deflections. Similarly, in continuous trusses, the angle changes are calculated from the strains in the actual structure, and then each span is treated as a simple span in the construction of the deflection diagram.

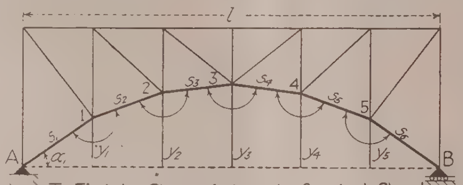
For a cantilever truss, Fig. 13, the deflection of the free end is given by the formula

$$\delta = \Sigma x \cdot \Delta\varphi \qquad (11)$$

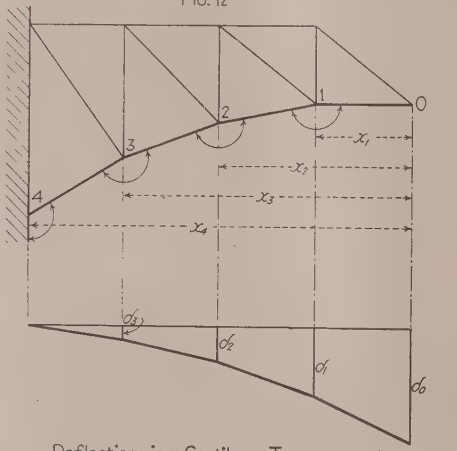
where x is the horizontal distance of each angle change from the free end. In other words the cantilever is treated as fixed at the free end and free at the fixed end when the angle changes are applied as weights. Extending the above principles to a cantilever bridge, we obtain the deflection diagram represented in Fig. 14.

In order to dispense with the necessity of making a separate correction for the effect of the line changes upon the deflections, the method of elastic weights is used. This method, in common with the preceding method, makes use of the angle changes in a truss, but differs from the preceding method in requiring the angle changes to be determined and applied at the center of moments for each member instead of at the contiguous panel points.

The kinematic basis for this procedure lies in the fact that the pole, or center of relative rotation, of two parts of a truss held together by any member coincides with the center of moments for that member. Thus, in Fig. 15, any strain in the chord member 3-5 produces relative rotation of the two segments of the truss with the center of moment C acting as a hinge or pole.



To Find the Change in Length of an Arch Chord
FIG. 12



Deflections in a Cantilever Truss
FIG. 13

Similarly, in Fig. 16, any strain in the diagonal 3-4 produces relative rotation of the two segments of the truss (shown shaded), with the pole, or virtual hinge, at the intersection of the connecting links 2-4 and 3-5; that is, at the center of moments C. In both cases the amount of relative rotation or angle change, measured in radians, is given by the formula

$$\Delta\varphi = \Delta s / r \qquad (12)$$

where Δs is the strain (elongation) in the member and r is its lever arm from the center of moments.

If the angle change $\Delta\varphi$ is applied at any point other than the true pole, a correction remains to be made for a translatory effect not covered by the rotation. But if the angle change is applied at the true pole—that is, at the center of moments C—the effect of each strain Δs becomes completely represented by a pure rotation, so that no correction is necessary for any additional effect of translation such as that of the line changes in the preceding method.

The method of elastic weights then consists in finding the angle change $\Delta\varphi$, defined by equation (12), for each member, and applying it as a weight at the corresponding center of moment; the resulting moment polygon constitutes the deflection diagram of the structure.

GENERAL PROOF

The following is a general proof of this principle: In the method of unit loads the stress S_1 in any member is equal to the bending moment M_1 at the center of moments C divided by the lever arm r. Consequently equation (3) for the deflection of any panel point X may be written, using equation (12),

$$\delta = S_1 \cdot \Delta s = \frac{M_1}{r} \cdot \Delta s = M_1 \cdot \Delta\varphi \qquad (13)$$

in which M_1 is the bending moment at C produced by a unit load applied at X. But, by virtue of the reciprocal relation for single loads between the bending moments at any two points of a span, M_1 also represents the bending moment at X producible by a unit load applied at C; and $\Delta\varphi \cdot M_1$ is therefore the bending moment at X producible by a load of $\Delta\varphi$ applied at C. Consequently equation (13) states that the deflections δ, due to the strain in any member, are equal to the bending moments produced by a weight $\Delta\varphi$ applied at the center of moments C. The total deflection diagram of a framed structure is therefore identical with the moment diagram of all the angle changes applied as weights at the respective centers of moments, which was to be proved.

For the effect of the chord members on truss deflections the method of elastic weights is identical in procedure with the preceding method (Fig. 8, Part 1). It is only in the method of including effect of web members that the two procedures differ.

APPLICATION TO CASE OF DIAGONAL

Fig. 16 shows the application of this method to the finding of the deflections produced by the elongation of a diagonal. In this case the pole or center of moments C is located outside of the span. As this is not a panel point of the truss, we cannot apply $\Delta\varphi$ as a weight directly at C. Instead we replace $\Delta\varphi$ by two other weights which will produce the same effect. These are the vertical components P and Q applied at the ends of the diagonal under consideration. If a and b are the respective horizontal distances of these two points from the pole C, and if p $(= b - a)$ is the distance between them, the general expression for P and Q may be written

$$P = \Delta\varphi \cdot \frac{b}{p} \text{ and } Q = -\Delta\varphi \cdot \frac{a}{p} \qquad (14)$$

P, being the component nearer to $\Delta\varphi$, always has the same sign as $\Delta\varphi$, and is larger than the other component Q. With these two weights acting on the truss, the resulting moment diagram $AMNB$ is constructed, and the ordinates of this diagram give the deflections of the different panel points due to the elongation of the diagonal d.

To find the deflections due to a vertical member (Fig. 17), the component weights P and Q are considered applied at the panel points of the loaded chord on either side of the section taken through the web member; these values of P and Q are also given by equation (14).

To find the total deflections of a truss, find the weights $\Delta\varphi$ for all the chord members by equation (12), and the weights P and Q for all the web members by equation (14), and then take the algebraic sum of all the weights at each panel point. These sums, which are to be applied as loads at the respective panel points, are called "elastic weights," and are represented by the symbol w. The moment diagram of the elastic weights constitutes the deflection diagram of the structure.

The above is the general procedure of the method of elastic weights. The work may be expedited, however, by transforming the above formulas into more convenient expressions.

If Δc is the elongation of any chord member and $\Delta' c$ is the same strain multiplied by the secant of its inclination to the horizontal, the contribution to the elastic weight, given by equation (12), reduces to

$$\Delta\varphi = \pm \Delta' c/h \qquad (15)$$

where h (Figs. 15, 18) is the height of the truss at the point of application of $\Delta\varphi$.

If h_1 and h_2 (Fig. 16) are the heights of the truss at P and Q respectively, and if r_1 and r_2 are the perpendiculars from the ends of h_1 and h_2 to the diagonal d, then P and Q are given by any of the following formulas:

$$P = \pm \frac{\Delta d}{r_1}, \qquad Q = \mp \frac{\Delta d}{r_2} \qquad (16)$$

$$P = \pm \frac{\Delta' d}{h_1}, \qquad Q = \mp \frac{\Delta' d}{h_2} \qquad (17)$$

where $\Delta' d$ represents the elongation of the diagonal multiplied by the secant of its inclination to the horizontal. If θ is the angle of this inclination, the component P or Q which acts at the upper end of the diagonal is given by the formula

$$P \text{ or } Q = -\Delta d/p \sin\theta \qquad (18)$$

For a vertical web member, v (Fig. 17), if P or Q is the component coinciding with v, the other is given by the simple formula

$$Q \text{ or } P = -\Delta v/p \qquad (19)$$

For any web member, if either P or Q is known, the other can be found from $P + Q = \Delta\varphi$, or from the ratio

$$P/Q = -b/a = -h_2/h_1 \qquad (20)$$

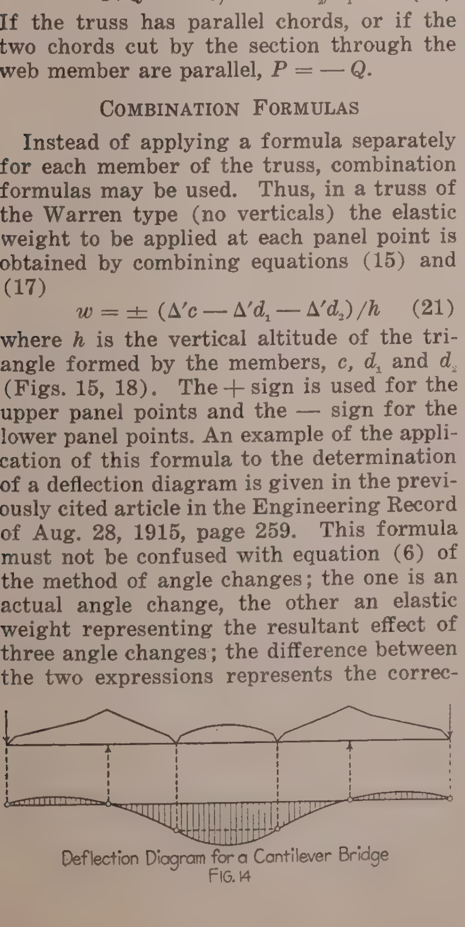
If the truss has parallel chords, or if the two chords cut by the section through the web member are parallel, $P = -Q$.

COMBINATION FORMULAS

Instead of applying a formula separately for each member of the truss, combination formulas may be used. Thus, in a truss of the Warren type (no verticals) the elastic weight to be applied at each panel point is obtained by combining equations (15) and (17)

$$w = \pm (\Delta' c - \Delta' d_1 - \Delta' d_2)/h \qquad (21)$$

where h is the vertical altitude of the triangle formed by the members, c, d_1 and d_2 (Figs. 15, 18). The + sign is used for the upper panel points and the — sign for the lower panel points. An example of the application of this formula to the determination of a deflection diagram is given in the previously cited article in the Engineering Record of Aug. 28, 1915, page 259. This formula must not be confused with equation (6) of the method of angle changes; the one is an actual angle change, the other an elastic weight representing the resultant effect of three angle changes; the difference between the two expressions represents the correction for the line changes in the web members.



Deflection Diagram for a Cantilever Bridge
FIG. 14

Another combination formula for the elastic weights in a Warren truss is

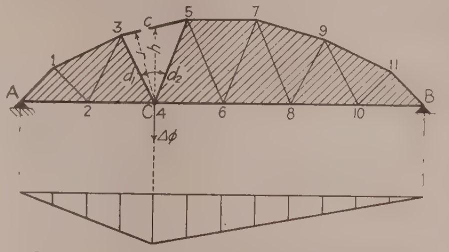
$$\pm w = \Delta' c/h - \Delta d_1/r_1 - \Delta d_2/r_2 \qquad (22)$$

where r_1 and r_2 are the perpendiculars from the foot of h to the two diagonals d_1 and d_2, Fig. 18.

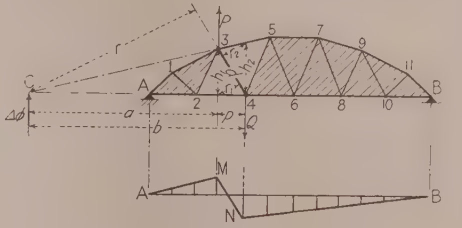
In a Pratt truss with parallel chords and vertical posts, Fig. 19, the elastic weight to be applied at each panel point of the lower chord is given by a combination of equations (15), (16) and (19):

$$w = \frac{\Delta c_2 - \Delta c_1}{h} + \frac{\Delta d_1 - \Delta d_2}{r_1} + \frac{\Delta v_2 - \Delta v_1}{p} \qquad (23)$$

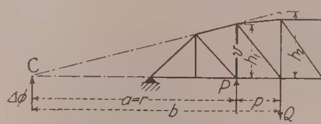
The sign of any elastic weight $\Delta\varphi$, P or Q, is always taken as plus if it tends to produce downward deflection of its point of application. Thus for chord members in a truss span $\Delta\varphi$ is plus (downward) for compression in a top-chord member or tension in a bottom-chord member. For a diagonal the components P and Q have opposite signs, and are assumed to be directed toward each other or away, according as the diagonal is in compression or tension. For a vertical the component P or Q at the foot of the member is taken as plus (downward) if the member is in tension.



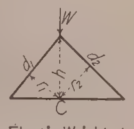
Contribution of a Chord Member to Truss Deflections
FIG. 15



Contribution of a Diagonal to Truss Deflections
FIG. 16



Contribution of a Vertical to Truss Deflections
FIG. 17

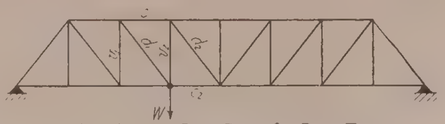


Elastic Weight at a Panel Point of a Warren Truss
FIG. 18

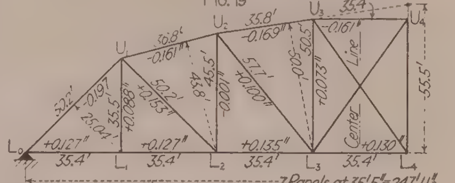
In the case of vertical hangers or posts whose strains affect the deflections of but a single panel point, it is best to disregard their strains until the deflection diagram is constructed; the correction is then made by equation (7), simply adding their strains to the ordinates of the deflection diagram. In the case of a truss having vertical web members the deflection diagram represents the displacements of the lower panel points only; the deflections of the upper chord may be obtained by correcting as above.

EXAMPLE 7—TO FIND THE DEFLECTIONS OF A TRUSS BY THE METHOD OF ELASTIC WEIGHTS

Fig. 20 represents a seven-panel Pratt truss with dimensions as indicated. The elastic strains (in inches) produced by the dead load plus a full live load of 6000 lb. per linear foot of truss are marked on the members in parentheses. The elastic weights are computed by equations (12), (17), (19) and (20) as in the accompanying table.



Elastic Weight at a Panel Point of a Pratt Truss
FIG. 19



Method of Elastic Weights Applied to an Inclined Chord Truss
FIG. 20

In the above evaluation of the elastic weights the diagonals U_3L_4 and U_4L_3 and the post U_2L_2 are omitted, as their strains are zero or negligible. The presence of two diagonals in the center panel is taken into account by using only one-half of the strains in the affected members (U_3U_4, L_3L_4, U_3L_3 and U_4L_4) in conjunction with each diagonal. Combining all the elastic weights at each panel point, and applying the method of successive summations, we obtain the deflections as follows:

Point	Elastic weight	Shear	Moment	Deflection, in.	
		0.0265			
L_1	0.0090		0.0265	0.94	(+ 0.09 = 1.03)
		0.0175			
L_2	0.0079		0.0440	1.56	
		0.0096			
L_3	0.0096		0.0536	1.90	

The moments in the above table are obtained by summation of the shears, assuming the length of panel as unity; consequently the values in the last column are obtained by multiplying the moments by the panel length, 35.4 ft. To the deflection of L_1 is added the correction for the elongation of the hanger which was previously omitted.

The above determination of the deflections is more expeditious than that of any other analytical method and more precise than that of the Williot diagram.

INFLUENCE LINES AND DEFLECTION DIAGRAMS

Referring back to Figs. 15 and 16, it may be noted that the deflection polygon in each case, besides being a deflection diagram for Δs and a moment polygon for the elastic weights, is also the influence line for the stress in the given member. This is an example of a general relation between influence lines and deflections, which may be deduced from equation (3a), $\delta = S_1 \cdot \Delta s$. If

ELASTIC WEIGHTS COMPUTED—EXAMPLE 7

Member	Strain (Δs)	Divisor	Elastic Weight ($\Delta\phi$)	Panel Point
L_0U_1	0.197	25.0	+ 0.0079	L_1
L_0L_2	0.254	35.5	0.0072	L_1
U_1U_2	0.161	43.8	0.0037	L_2
L_2L_3	0.135	45.5	0.0030	L_2
U_2U_3	0.169	50.0	0.0034	L_3
L_3L_4	0.065	50.5	0.0013	L_3
U_3U_4	0.080	50.5	0.0016	L_3
		Multiplier	P and Q	
U_1L_2	0.153	$\frac{-50.2}{35.4 \times 35.5}$	P, — 0.0061	L_1
		*35.5/45.5	Q, + 0.0048	L_2
U_2L_3	0.100	$\frac{-57.7}{35.4 \times 45.5}$	P, — 0.0036	L_2
		*45.5/50.5	Q, + 0.0032	L_3
U_3L_3	0.036	1/35.4	P, + 0.0010	L_3
		*— 50.5/55.5	Q, — 0.0009	L_3

*Multiplied by P.

we make $\Delta s = 1$, then $\delta = S_1$; that is, the deflections δ will be equal to the stress S_1 produced in the member by a unit load moving over the span. In other words:

> The influence line for the stress in any member is identical with the deflection diagram produced by increasing the length of that member by unity ($\Delta s = 1$).

The same relation between influence lines and deflections is also applied in the design of indeterminate structures in the form of the following principle:

> The influence line for any external reaction is the deflection diagram produced by a unit displacement of the point of application of that reaction.

Another useful relation which may be deduced from equation (3) is Maxwell's principle. If S_m and S_n are the stresses produced by a unit load at panel points m and n respectively, the deflection of m due to a unit load at n and the deflection at n due to a unit load at m are both given by the same expression from equations (1) and (3),

$$\delta = \Sigma S_m \cdot S_n \cdot s/EA \qquad (24)$$

Hence the two deflections are equal, which constitutes Maxwell's principle. From this principle we derive this relation:

> The deflection diagram for a unit load at any panel point is also the influence line for the deflections of that panel point.

By applying the above principles, the methods of angle changes and elastic weights may be used to construct influence lines for stresses, reactions and deflections as well as deflection diagrams.

Literature

For the Civil Engineer and Contractor

New Publications

VALUE FOR RATE-MAKING. By Henry Floy, A.B., M.A., M.E., consulting engineer. Cloth, 6 x 9 in.; 322 pages; illustrated. New York, McGraw-Hill Book Company, Inc. $4 net.

FIVE-FIGURE MATHEMATICAL TABLES. Compiled by E. Chappell, B.Sc. Cloth, 6 x 9 in.; 320 pages. New York, D. Van Nostrand Company; London, W. & R. Chambers, Ltd. $2 net.

HYDRAULICS.—By R. L. Daugherty, A.B., M.E., assistant professor of hydraulics, Cornell University. Cloth, 6 x 9 in.; 267 pages; illustrated. New York, McGraw-Hill Book Company, Inc. $2.50 net.

EARTH PRESSURE, RETAINING WALLS AND BINS. By William Cain, professor of mathematics, University of Carolina. Cloth, 6 x 9 in.; 287 pages; illustrated. New York, John Wiley & Sons, Inc. $2.50 net.

GROUND WATER IN SAN JOAQUIN VALLEY, CALIFORNIA. By W. C. Mendenhall, R. B. Dole and Herman Stabler. Water-Supply Paper 398. Paper, 6 x 9 in.; 310 pages; illustrated. Washington, Government Printing Office.

METRIC SYSTEM IN EXPORT TRADE. Report by S. W. Stratton, director, U. S. Bureau of Standards, to the International High Commission. Paper, 6 x 9 in.; 80 pages; illustrated. Washington, Government Printing Office, Senate Document 241.

PROCEEDINGS OF THE CITY MANAGERS' ASSOCIATION, 1915. Paper, 6 x 9 in.; 144 pages; illustrated. Niagara Falls, N. Y., published by the association, O. E. Carr, secretary.

Second annual report giving the proceedings at the meeting in Dayton, Ohio, Nov. 15-17, 1915.

THE AMERICAN ROAD. A Non-Engineering Manual for Practical Road Builders. By James I. Tucker, professor of civil engineering, University of Oklahoma, and consulting state engineer, Oklahoma Department of Highways. Cloth, 5 x 7½ in.; 235 pages; illustrated. Norman, Okla., The American Road. $1.08 net.

THE SPIRIT OF CAUTION. Monthly periodical started by the Conference Board on Safety and Sanitation. Paper, 5 x 8 in.; 12 pages; illustrated. West Lynn, Mass.; Magnus W. Alexander, executive secretary.

Prepared primarily for the use and guidance of managers, superintendents and foremen in manufacturing plants.

GENERAL SPECIFICATIONS FOR CONCRETE BRIDGES. Third edition. By Wilbur J. Watson. Paper, 8 x 11 in.; 70 pages; illustrated.

This third edition brings up to date the matter issued in the previous editions, the first in 1908 and the second in 1910, by some radical changes, especially in the section on quality of materials. The sections on waterproofing and surface finish have been entirely rewritten.

THE PANAMA CANAL—A Series of Papers Covering in Full Detail the Technical Problems Involved in the Construction of the Canal. Prepared under the direction of George W. Goethals, major general, U. S. Army, and Governor of the Canal Zone, by engineers and other specialists in charge of various branches of the work and presented at the International Engineering Congress, 1915. Two volumes, 25 papers. Cloth, 6 x 9 in.; 527 and 483 pages respectively; illustrated. New York, McGraw-Hill Book Company, Inc. $7.50 net per set.

OREGON'S OPPORTUNITY IN NATIONAL PREPAREDNESS. Bulletin No. 5, Office of the State Engineer, Salem, Ore. By John H. Lewis, state engineer, L. F. Harza of Portland, Garfield Stubblefield and E. J. McCaustland. Paper, 5¾ x 8½ in.; 120 pages; illustrated.

A presentation of tentative plans and estimates of cost for the construction of certain large water power projects estimated to be capable of developing 2,400,000 hp., discussing possibilities for marketing some of this power, and pointing out the direct and indirect benefits which will come through the early development of the water power resources of Oregon.

Books Reviewed

Geodetic Surveying

Author, Edward R. Cary, professor of railroad engineering and geodesy, Rensselaer Polytechnic Institute. Cloth, 8 x 5½ in.; 272 pages, 98 illustrations, 21 tables. New York, John Wiley & Sons, Inc. $2.50 net.

REVIEWED BY A. F. COMSTOCK

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Those who have followed the recent advances in methods and instruments of precise measurement will appreciate the need of a text setting forth in usable form the principles and modern aspects of geodetic surveying. Such a book is the one under review. A brief description of the book might well read as follows: "A concise, well-balanced textbook embodying the essentials of geodetic surveying, including geodetic astronomy and the method of least squares." Geodetic surveying proper is confined to the eight chapters which form the main part (three-fourths) of the book, while the appendices are restricted to astronomical considerations and least squares. Many of the methods presented are those of the U. S. Coast and Geodetic Survey. The author comments most favorably upon the results achieved by this organization.

Starting with a short introduction and an equally short chapter on reconnaissance. there follows a 30-page chapter on base lines. Chapters 3 to 7, inclusive, take up horizontal angles; adjustment of the horizontal angles; computation of geodetic latitudes, longitudes and azimuths; map projections, and trigonometric leveling. In general these chapters are brief—they average but fifteen pages each—but brevity has clearly been achieved by studious and legitimate condensation. Chapter 8 on precise leveling is a 40-page discussion taken principally from the reports and instructions of the U. S. Coast and Geodetic Survey. Throughout these eight chapters the numerous mathematical derivations and formulas involved have been presented with facility. A dozen typical problems are worked out at intervals to illustrate difficult applications, and a fair sprinkling of halftones and tables adds to the completeness of the several chapters. The measure and standards of precision have been duly emphasized.

The two appendices constitute one-fourth of the book. Appendix 1 treats of time, longitude, latitude and azimuth, and Appendix 2 takes up the method of least squares. Both are compact and to the point; they summarize these two related subjects in a judicious way, while numerous problems are worked out to supplement the text. Following the appendices is a list of some thirty references to the literature of the subject. The book impresses one as being a first-class, usable text.

Good Roads Year Book

Good Roads Year Book for 1916 (Fifth Edition). Cloth, 6 x 9 in., 440 pages. Washington, D. C., Colorado Building, American Highway Association, $1.

This, the fifth edition of the Good Roads Year Book, fully maintains the valuable place which its predecessors have made for this annual publication. The work is invaluable to libraries, associations, corporations and individuals requiring reference to highway laws, practices and statistics.

The main divisions of the work follow those of the last volume, but the arrangement has been improved, so that the book is better adapted for reference than its predecessors. The index in the front has been better displayed—dividing the book into three principal parts—while a detailed index at the end leads one directly to the subject sought.

Part 1 gives information regarding road improvements under federal, state, territorial and local control, together with a digest of the laws under which the work is executed. Here also are given the names of officials responsible for highway work.

Part 2 contains historical notes, technical details of road construction and maintenance, and a summary of road practice in European countries.

Part 3 is a miscellaneous section, containing discussions of highway bond issues, a bibliography, and lists of manufacturers, of highway and allied associations, and of road materials and road machinery.

While the value of each particular part of the book will depend upon the field in which the user is working, it is worth while calling especial attention to the digest of state highway specifications. It is a most valuable comparative summary of practice in different parts of the country.

Sewerage

Author, A. Prescott Folwell, past-president, American Society of Municipal Improvements. Cloth, 6 x 9 in.; 540 pages, 46 illustrations, 31 tables. New York, John Wiley & Sons, Inc., $3 net.

REVIEWED BY CHARLES E. GREGORY

Engineer in Charge of Sewers, Department of Public Works, Borough of Manhattan, New York City

The seventh edition of "Sewerage," by A. Prescott Folwell, directs attention again to one of the older and most used text-books on sewerage. This work did not originally assume to treat at length the subject of sewage disposal, but recent developments in the art of sewage treatment and a more universal belief in the need for treatment has caused the author to revise and add to Part 4 of his work.

The older portion of the work may be very briefly reviewed with profit. Chapter 1 concisely defines various sewerage systems and methods and shows the water-carriage system the only one worthy of consideration under usual conditions. Chapter 2 gives the usual assumptions for determining quantity of sewage to provide for.

Chapters 3, 4 and 5 are devoted to rather elementary discussions of flow, flushing and collecting data. Chapters 6, 7 and 8 cover in a little more than 100 pages the preparation of drawings and specifications for sewer work, not including treatment plants.

Part 2 includes about 100 pages on construction. In twenty pages of Part 3 the usual maintenance practice is described.

Part 4 covers the field of sewage disposal in 155 pages devoting considerable space to dilution, composition of sewage and general principles of pollution and treatment. The significance of the quantity of dissolved oxygen in a polluted body of water as a measure of the pollution and an indication of the approach of malodorous conditions is not brought out.

Under "Methods of Treatment" the various devices for treating sewage are concisely described.

Under the head of of "Straining" various coarse and fine screens are described and data are quoted from Kenneth Allen's recent paper read before the American Society of Civil Engineers.

The various tank treatments, including chemical precipitation, are very lucidly covered. Examples of plants and tables of results are given. This chapter is especially meritorious.

A special article is devoted to oxidation, and very properly emphasizes the importance of oxidation in any complete purification of sewage, and quotes Dr. Rideal as to these processes. There is also described the design and maintenance of intermittent filters, and George W. Fuller in the report of the Massachusetts State Board of Health for 1893 is quoted.

Contact beds and sprinkling filters are described and much valuable advice is given as to their design and operation. Details are given of the modern types of sewage sprinkling nozzles, and Prof. Earl B. Phelps' method of expressing efficiency of sprinkling filters is described.

The article on the "Disinfection of Sewage" includes considerable data on costs, as well as upon the methods employed and results obtained.

While the space given to "activated" sludge is small, it gives the experience gained at Milwaukee in general terms. It does not go into details or show designs of works or devices. The author is wise in this, because this method of treatment has not yet reached a stage of practical development which warrants a permanent text-book description of details.

In describing the "Electrolytic Treatment" great weight is given to a report by three experts, including Prof. W. P. Mason, on the electro-chemical process which was carried out at Elmhurst, Borough of Queens, and not in Brooklyn, N. Y., as stated. Many of the results given in this report were not verified by other investigators of the same plant. While a satisfactory effluent was obtained the sewage which actually entered the electrolytic machine was abnormally weak, and its strength fluctuated between wide limits within short periods of time, thus making the results obtained open to doubt. Other investigations seem to indicate that the passage of the low-tension direct-electrical current through the liquid had very little beneficial effect. Both the sludge and the effluent became putrescible in two days after the alkalinity had been neutralized. Comparison of effluent between sewage treated with the electrical current and that treated in the same machine and plant with the electrical current turned off showed very slight difference in result, except in the one case quoted by the report of the experts above referred to.

The cost of this process as reported by Professor Mason and his colleagues was $30.19 per million gallons for a 1,000,000-gal. unit, and $22.28 for a 3,000,000-gal. unit. These costs do not include pumping, which would usually be necessary, nor the fixed charges to cover the cost of the electrolytic apparatus, sedimentation tanks, pump well, grit chambers, land, fine screening, sludge pressing and disposal machinery, which would probably very nearly double the actual cost of treatment by this method.

A brief description is given of rapid sand filters and of the Kessel siphon tank. The article on "Disposal of Sludge" briefly describes the composition of sludge, states its manurial value.

The work as a whole is clearly and concisely written, is free from conflicting data, and is admirably adapted for text-book uses and for reference library work.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

New York Central West Side Improvement in New York

SIR: In connection with your editorial in relation to the proposed New York Central West Side improvement, in your issue of May 6, page 599, permit us to add somewhat to your statement. As engineers for the conference committee of the various civic organizations who are and have been for some years vitally interested in securing a proper solution of this problem, we prepared the "citizens' plan," for a tunnel route, as the railroad and some of the city officials had assumed that the only possible solution of the problem was the railroad plan advanced in 1913.

That the labors of these civic organizations were not in vain is shown by the plan at present under consideration, which is a distinct and decided improvement on any of its predecessors, from both railroad and civic point of view, though far from being entirely complete or satisfactory.

The chief expenditure by the railroad will be made to secure improved terminal and track facilities, fully worth their expense, which afford a practical monopoly of the freight facilities of Manhattan. The railroad is further to gain an opportunity for the relief of its passenger traffic by running its express trains, at no far distant date, along the west side, and so relieving the congestion on its Park Avenue line.

The cost of covering over the tracks in Riverside Park, Fort Washington Park and Inwood Hill seems to be more than compensated for by the $6,000,000 difference in realty values involved in the proposed exchange of lands between the railroad and the city.

As to those who desire to reserve to the city the right to roof over the 129th Street freight yard at some future time, and at the city's expense, permit us to say that from their point of view as real-estate owners and taxpayers, they are not idealists but rather very practical people. In spite of electric operation, a freight yard is not likely to enhance but rather to depreciate the value of any property that may adjoin it.

As to future marginal terminal improvements, all that is now asked for is the right of the city to go over or under the proposed downtown structures of the New York Central should it be desired at some future time to provide terminal facilities for the roads now terminating on the Jersey shore. If this is not done, our progressive neighbors in New Jersey may eclipse the port facilities of New York by newer and better conditions in New Jersey, and New York City will retain only such freight from these roads as is intended for its own use, while the export freights will be diverted to the New Jersey terminals and docks.

The civic organizations are all in accord in desiring that the railroad should have all necessary facilities for its present business and future development, but they ask that this be done with due regard to the rights of the public and the reasonable interests of real estate affected. Their suggestions and criticisms have been recognized as helpful by the city authorities, and the railroad plans have gained somewhat by them. The operation is so large a matter that it would be very unfortunate if every detail and contingency is not thoroughly worked out in advance.

The amount which the railroad asserts it is going to spend upon the project, the extent of which is a mere assertion on its part, should not be allowed to affect the careful investigation of the details.

The railroad's future interests in some respects do not appear to be as well provided for, in this plan, as by the "citizens' plan."

THE R. P. BOLTON COMPANY,
Reginald Pelham Bolton, President.
New York City.

[Mr. Bolton's fears regarding the possibility of the New York Central securing a permanent monopoly south of Thirtieth Street should be allayed by the second report of the port and terminal committee of the Board of Estimate, made public early this week. The committee points out that this section of the line will cross thirty-six streets, and at thirty-four of these the city reserves the right to cross over, under or at grade.

Mr. Bolton's statement that the railroad is making its chief expenditure for improved terminal and track facilities does not seem quite fair. Surely $15,000,000 for park treatment is not to be scorned. Obviously the railroad, in justice to its stockholders and the ratepaying public, could not offer to spend $50,000,000 or more without expecting compensating advantages of some sort. Nevertheless the city will gain much at little expense to itself, and even in the exchange of land, whatever the comparative values of individual parcels, the city seems to be the gainer when the whole project is considered.

The port and terminal committee says regarding the covering of the Manhattanville yard, that there are foundation difficulties making it practically impossible. The Engineering Record cannot see any great likelihood of a serious nuisance in an electrically operated yard from 30 to 45 ft. below the parapet of a broad level strip of park.

The Engineering Record agrees with Mr. Bolton that so far-reaching an improvement should be studied out in detail before adoption. Apparently, however, the studying has been done; certainly it cannot go on forever. And it appears to this journal that the main obstacles have been overcome, and that the importance of carrying out the project as a whole as soon as possible far transcends the sum total of all of the objections that have been raised to it in detail.—EDITOR.]

Surveys and Bench Marks—More Permanence Needed

SIR: I would like to suggest a more general use of sea-level datum and reference ties to public land lines for all surveys, the lack of which will generally be found to be weak points in many surveys. The too frequent practice of using assumed bench marks, such as spikes in trees, or tops of curbs, should be discontinued wherever practicable. Reference points, such as stakes and marks opposite center of structures, are often used instead of township and section lines. It is only a question of a few years before assumed bench marks and reference points will be destroyed, and the surveys will be practically valueless for future use.

Recently I desired records of high-water marks along a certain strip of land to use in establishing a high-water plane. Several dozen surveys, which had been made for permanent bridge work and which contained high-water records, were obtained from the files. As is often the case, the surveys had been made from assumed bench marks. The connecting links were missing and the surveys were valueless for my purpose.

One finds many maps, profiles, and topographical surveys on file in engineering offices bearing practically no direct relation to each other. Engineers have had occasion in valuation work, and in lawsuits involving surveys, to handle maps and profiles the value of which would have been intrinsic if only some relation between the maps and the profiles could have been established. The engineering departments of both small and large corporations are more or less at fault in the matter of allowing surveys to be made and filed which are of practically no future value.

The federal government has established sea-level bench marks and permanent land lines in many parts of this country, and their use should become more general in surveys of all kinds. The more general use of sea-level datum and land-line ties for surveys will aid greatly in reducing the duplication of field surveys, and will tend toward inaugurating a more permanent and economical policy in the making and filing of surveys.

F. D. YEATON.

Oak Park, Ill.

Justice to the Contractor

SIR: I heartily indorse your editorial suggestion "Justice to the Contractor" on page 502 of the Engineering Record for April 15.

The American Society of Civil Engineers could very properly draft general clauses and specifications including the general principles which should govern the preparation of detailed specifications. To encourage the adoption of these standard specifications at the earliest time possible it would seem advisable to include a brief statement of the advantages of the form of specifications proposed and explain how these specifications would eliminate the many present abuses. These statements and explanations should be written in plain, popular language so the layman could grasp and understand them readily.

Before much improvement can be made along these lines public officials and the public in general must know the difference between blue prints and specifications. They must also know the essential things the plans and specifications should contain to properly safeguard both parties to the contract. The attitude of many public officials is at present to require the specifications to be made as rigid as possible, for they feel that the contractor will get more than is coming to him in spite of all they can do in any case. Under such specifications the bids are generally made on what the contractors know about the officials and their engineer instead of on the specifications.

Education on the sound business principles of handling public business and the realization of the necessity of employing competent engineers and paying them well for directing this work will overcome many of these unsatisfactory conditions.

In order to overcome the objection to making the county engineer sole judge of the contract, plans and specifications I propose to use the following clause in my standard specifications for county highway bridge work.

"It is hereby agreed by both parties to this contract that the engineer shall act as referee in all questions and disputes arising under the terms of this contract between the parties thereto, and that the decision of the engineer in all such cases shall be final and binding upon both parties alike, unless an appeal is made from such decision, in which case both parties hereby agree that before any action shall be started in any court the question or questions at issue under this contract shall be referred to an arbitrator selected jointly by the contracting parties. The arbitrator shall be a graduate civil engineer who has had not less than ten years' experience in highway bridge work and who is not connected or interested in any way with any bridge contractor. The party losing the decision shall pay the fees of the arbitrator and all the expenses incurred by him in making the investigations and preparing and submitting reports."

Such a provision would probably be some restraint on the engineer, and it would have a tendency to discourage claims that could not and should not be sustained, and it seems only fair that the party who erred in his judgment as to the reasonable and proper interpretation of the contract should pay the expense of the arbitration.

I should be very glad to support a movement to correct the abuses referred to.

W. S. GEARHART,
State Engineer.

Manhattan, Kan.

SIR: I have read your editorial entitled, "Justice to the Contractor." There is merit and justice in your attitude in this editorial. However, it would be well not to lose sight of the fact that many contractors are so accustomed to "putting things over," to use an everyday vernacular, that when they do work that is run on the level they are constantly kicking and fighting with the engineer either to intimidate him into letting them do inferior work or slip something by when he is not looking.

It is my opinion that there are many good contractors who are eminently fair; men who have reputations to sustain and who do sustain them by ofttimes doing much more than the formal provisions of the contract provide for, and it is to this class of men that we should give protection against unjust tactics on the part of men not qualified to judge as to what is equitable and fair.

I am very much interested in this question as it is a live one with us all the time, and I would gladly help in any movement to correct these conditions. It has been suggested in your editorial that the American Society of Civil Engineers is best qualified to do this work. That suggestion is a good one and it would seem as though the Society could appoint a committee of engineers and contractors, for there are many contractors in the Society who are engineers, to take up this problem and report to the Society as a whole with suggestions. I think if it is done in that manner that it will give the whole thing more weight than could be achieved in any other manner. But, of course, it would be necessary to have the help of the engineering press in bringing about a change in conditions, for many men who are not members of the Society would be slow to take up any change of this nature unless it had been strongly advocated by the engineering press.

Yours very truly,
H. E. BREED,
First Deputy Commissioner of Highways,
State of New York.
Albany, N. Y.

Stream-Flow Measurements

Since 1888, according to a bulletin of the U. S. Geological Survey, measurements of stream-flow have been made by the Survey at about 3000 points in the United States. In addition, measurements have been made at many points in small areas in the Seward Peninsula and the Yukon-Tanana region, Alaska, and in the Hawaiian Islands. In this work many private and state organizations have co-operated, either by furnishing data or by providing financial assistance in collecting the data. In July, 1913, about 1380 stations were maintained by the Survey and the co-operating organizations, and many measurements of discharge were made at other points.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

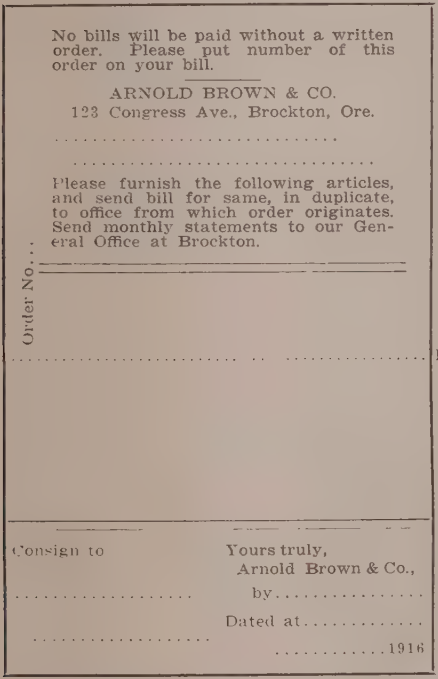
[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Accounting for the Contractor—Order Blanks

By BENJAMIN L. LATHROP

Lathrop, Shea & Henwood Company, Scranton, Pa.

THESE suggestions are offered especially to the small contractor, whose system of accounting is often started along wrong lines. Such a system may seem adequate for his needs, but if his business expands he finds it necessary to install new methods from time to time, involving considerable experimental accounting before he learns just what is needed to meet the demands of a growing business. It is just as easy to start right, and save the confusion incident to repeated changes. First the order blank will be considered.


No bills will be paid without a written order. Please put number of this order on your bill.

ARNOLD BROWN & CO.
123 Congress Ave., Brockton, Ore.

. . . .

. . . .

Please furnish the following articles, and send bill for same, in duplicate, to office from which order originates. Send monthly statements to our General Office at Brockton.

Order No. . . .

A . . . . B

Consign to

. . . .

. . . .

Yours truly,
Arnold Brown & Co.,
by . . . .
Dated at . . . .
. . . . 1916

Even when an order for goods is given by a personal interview or over the telephone, it should be confirmed by a written order. A carbon copy should be kept on file for ready reference. The form illustrated herewith should be printed on paper cut to measure 8½ in. from left to right and 9 in. from top to bottom. This, when folded once, makes just the right size to fit into a standard document file, the most convenient device for filing order blanks, estimate sheets, invoices, etc. If the enterprise is a new one and it is felt that the outlay for filing equipment is not justified at first, this form can be kept in bundles secured by elastic bands, or placed in pasteboard boxes of convenient size. The important thing is to have the blanks of standard size and form, so that when the time comes to install a filing cabinet the papers can be transferred to it without inconvenience.

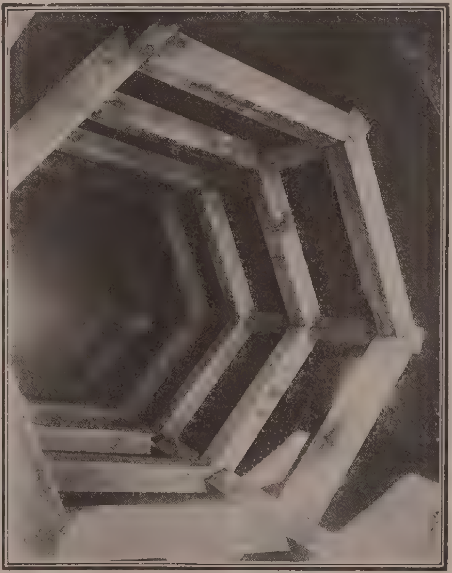
Orders should be written in duplicate or triplicate according to the requirements of the business, the original to be delivered to the consignor and one or two copies held for the office file. The form shown herewith is a modification of one that has proved satisfactory in actual use. The dotted line *A-B*, of course, does not appear on the form. It is shown to indicate the fold. The duplicate should be folded back along this line and placed in the document file with the order number at the top.

If the expense of order blanks is thought unnecessary until the business is more thoroughly established, an ordinary 8½ by 11-in. letter sheet may be used by folding under the lower margin of the duplicate 2 in., then folding the sheet back 4½ in. from the top and placing the order number in the left-hand margin, as indicated.

[This article is the first of a series by Mr. Lathrop on office and accounting methods for contractors. These articles will undoubtedly prove suggestive not merely to those starting in business, but also to the accounting forces of many established firms.—EDITOR.]

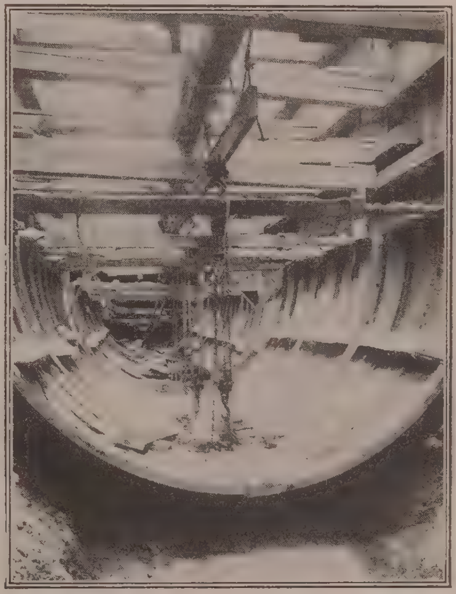
Sink Thin Steel Shaft Lining Outside of Hexagonal Bracing

THE SHORE shaft of the Wilson Avenue water tunnel, Chicago, is driven for the first 20 ft. through water-bearing sand. To exclude the water a ⅜-in. steel shell was sunk to a seal in the stiff underlying clay outside of a hexagonal set of bracing, as shown in the accompanying photograph. The excavation was started, according to H. L. Clausen, engineer of waterworks construction, in a recent paper presented to the Western Society of Engineers, with an 18-ft. square set of bracing and sheeting inside of which the steel shell was started. The latter is 13½ ft. in diameter and was brought on the job in five 6-ft. sections, 30 ft. in all, and riveted and caulked section by section. It was sunk into place by digging in the center and loading the shell with 140 tons of pig iron. Below the shell wood lagging with standard caisson rings was used to the rock surface, from which the shaft was lined with concrete to the top.


HEXAGONAL BRACING KEEPS THIN SHEET LINING IN PLACE

Sewer Forms Hung from Channel Trolley on Chain Blocks

THE SCHEME illustrated herewith of hanging steel sewer invert forms on chain blocks from a channel trolley track has been used successfully in building trench sections of the south side storm sewer in Columbus, Ohio, by J. C. Carland & Company, the contractors. The section of the sewer for which this method was devised is 10 ft. 3 in. in diameter. A section of the Blaw invert forms is lifted by three chain blocks, each hung from a three-wheel trolley running on a 7-in. channel which is suspended by chains from the trench bracing overhead. The forms are raised clear, run ahead on the trolley and lowered on cement blocks which are set to grade to support the forms in the trench ahead of the last section concreted. Three trolleys carrying a set of forms are easily pulled ahead by three men with a single rope pulley. The two 20-ft. sections can be moved, set and braced in from two to three hours by five men. The arch forms are pulled ahead on rollers on a track of doubled 2-in. plank. It also takes about three hours for five men to move ahead and set 60 ft. of the arch forms.


SEWER FORM CARRIED AHEAD ON TROLLEY

The south side storm sewer, the main trunk of which is more than a mile long, is being built for the city of Columbus, which is represented on the work by R. C. Chaney, assistant engineer under W. J. Weaver, engineer in charge of sewer con-

SHEETING IN RIGHT VIEW SHOWN AT LEFT AFTER IT HAD BEEN JETTED THROUGH HARDPAN WITH HELP OF 400 POUNDS WATER PRESSURE

struction, and Henry Maetzel, chief of the city engineering department. Charles E. Cannell is manager and H. R. De Lorme secretary of the contracting firm.

Wood Sheet Piles Jetted Into Hard Pan with 400 Pounds Pressure

By K. D. MacLEAN
Seattle, Wash.

A WATER jet under 400 to 450-lb. pressure has recently been successfully employed by the writer in driving wood sheet piles through hard pan which was so tough that it could scarcely be penetrated with a pick. This was done in driving the cofferdams for the north side piers of the city bridge over the Lake Washington Canal at Fifteenth Avenue, N. W., Seattle. The footings for the north side piers were built in two excavations each surrounded by a single row of the sheet piling shown in the accompanying photographs, and both entirely surrounded by an outside row of sheeting. The space between the outside sheeting and the two inclosed cofferdams was filled with clay puddle.

The borings showed about 1 ft. of sand, 4 ft. of blue clay, 8 ft. of hardpan, another thin seam of sand and then more hardpan. The foundation work had been sublet, and, contrary to the original intention, the subcontractors started to drive the cofferdams without doing any preliminary dredging. When the hardpan was encountered it was found impossible to drive the piling any further. In the south side piers a trench was dug around the inside of the sheeting and filled with sacks of earth, nearly 5000 of which were required for one pier. These were taken out in short sections at a time, the trench excavated and the material dug out from beneath the piles so they could be driven down. This proved so expensive and difficult that the general contractor had to take over the south side piers and complete them.

Those on the north side were again sublet in the condition in which they were left by the previous sub-contractor, that is with the piles driven to hardpan. The writer then undertook to put the piling to grade.

The only equipment retained on the work was a stiffleg derrick with a set of swinging leads and a drop hammer. A Blake duplex pump with a 5-in. intake and 4-in. discharge and 12 x 14-in. cylinders was set up and the 4-in. line carried about 50 ft. to a point between the two inside cofferdams, from where a 50-ft. hose reached all points of both. Considerable trouble was experienced in securing a hose that would withstand such high pressure, and the largest one obtainable was only 1½ in. in diameter, rubber hose wire wrapped, which, however, proved satisfactory. To this was attached a 30-ft. jet pipe, 2-in. diameter, double strength, with the nozzle drawn down to ¼ x 1¼ in. and case hardened. The pump was run by a 100-hp. boiler carrying 160 lb. steam pressure, and a working pressure of between 400 and 450 lb. at the pump was maintained.

The piling had to be driven 36 ft. below extreme high tide, 32 ft. below the top set of timbers and from 20 to 24 ft. below the ground line. The water was kept pumped down in the cofferdams so that this depth could be reached by the jet. The jet pipe was hung from the derrick from behind the leads, and was handled by three men. It was started down the front of the pile with a slight angle outward. When the hardpan was encountered all three men put their weight on the pipe by standing on a pair of handles clasped around it. In order to keep as straight a line as possible and prevent unnecessary strain on the splines, each pile was driven 5 or 6 ft. at a time working around the wall until all had reached a penetration of about 1 ft. below the grade of the bottom of the pier.

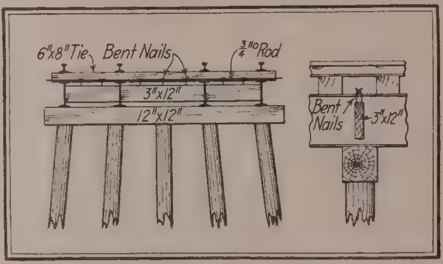
The greatest difficulty was found to be in driving through a stratum of gravel encountered in one corner of pier No. 1, which was coarse, closing in around the jet after it had been displaced, making the jet hard to remove and leaving no opening for the pile. Here the point of the jet had to be kept just below the tip of the pile, which often resulted in the jet being caught by the pile and having to be pulled with the derrick. This, however, did not result in any injuries to the pipe. Care had to be taken to work slowly through the blue clay, as the closing of the nozzle by plunging the jet into this clay would sometimes raise the pressure in the line to 600 lb. or more. Three times during the process of the work the pressure line was torn to pieces as though it were paper.

Jetting through the hardpan presented no difficulties other than the high pressure required to penetrate it. When the jet was removed the hole remained open and the pile was driven into it with an average penetration of 6 in. per blow, using a 5-ft. drop. A hole was required under each pile and in a few cases two were necessary, showing that the action of the water did not affect the ground at any distance from the tip of the nozzle.

The "Labor Map" in the Contracting News Section Shows Conditions in the Territory That Interests You

I-Beam Trestle Stringers Made Secure Without Punching Holes

THE SEPARATORS shown in the accompanying sketch are used by the Robert Grace Contracting Company to brace 18-in. I-beam trestle stringers securely without punching the beams for any connections. As the beams are lapped by over the caps of the trestle bents, they are not injured in any way by using them for stringers. A trestle construction with high salvage value, able to support 5-ton locomotive cranes and heavy concrete trains, is made in this way with long spans which reduce pile driving to the minimum required to carry the load. The spans in the trestle of this type used on the bridge at Milton, Pa., described on page 676 of this issue, averaged 18 ft. in length. The work is in charge of F. P. Kemon for the contractor.



PLANK SEPARATORS HUNG FROM ROD

Sand-Lime Brick Industry Firmly Established

In a report on sand-lime brick recently issued by the U. S. Geological Survey it is stated that the sand-lime brick industry, after experiencing the ups and downs of a new industry, has become firmly established. The sales of the product in 1915 attained a value $1,135,104, an increase of over $75,000 over the value in 1914. Michigan marketed more than any other state. Minnesota ranked second and New York third.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

E. L. Corthell, President of American Society of Civil Engineers, Is Dead

Engineer of International Reputation Succumbs to Stomach Disease at Hospital in Albany, N. Y., This Week—Had Unusually Varied Experience on Large Projects

Elmer Lawrence Corthell, Dr. Sc., president of the American Society of Civil Engineers, consulting engineer with a reputation that extended to three continents, bridge and railway builder, Civil War veteran, river and harbor expert and member of a score of scientific societies in this country and abroad, died in a hospital at Albany, N. Y., Tuesday afternoon from a disease of the stomach. Dr. Corthell occupied a unique position in American practice. In these days of specialization the tendency of engineers is to confine their professional work to a single field, but Dr. Corthell's activities covered a remarkably wide range of operations—bridges, railroads and terminals, river channel rectification, harbors, canals, waterworks, protection of sandy coasts from sea erosion—involving responsible charge of projects calling for an aggregate expenditure well in excess of $200,000,000. But even amid the press of his many professional engagements he found time to participate actively in the affairs of the engineer, particularly as they related to matters of public policy. He was always prominent at international congresses of engineers, where his European and South American experience made him an invaluable member of committees having in charge the organization and administration of such meetings. Early this year he achieved the highest distinction which it is possible for civil engineers to confer upon a member of their profession—the presidency of the American Society of Civil Engineers.

President of American Society of Civil Engineers and Consulting Engineer of International Reputation, Who Died This Week

DR. ELMER LAWRENCE CORTHELL

Enlisted in Civil War

Elmer Lawrence Corthell was born at South Abington, Mass., in 1840 and had been at Brown University two years when the Civil War broke out. He enlisted as a private in the First Regiment, Rhode Island Light Artillery, and in his service of four and one-quarter years, nearly all of the time in Virginia and North Carolina, he was advanced to the grade of captain. After the war he re-entered Brown University and received the degrees of B.A. and M.A. Later, in recognition of his professinal achievements, his alma mater conferred on him the honorary degree of Doctor of Science.

Upon leaving the university he entered a general engineering office in Providence and engaged in railroad, hydraulic and municipal work, resigning in 1868 to devote his entire attention to railroad work in the Middle West. After two years he became assistant engineer in charge of constructing the bridge over the Mississippi River at Hannibal, Mo., and from 1871 to 1874 served as chief engineer of the Sny Island levee, 51 miles in length, on the east bank of the Mississippi River in Illinois.

Dr. Corthell's name is closely linked with the history of the control of the Mississippi River and in 1875 he was engaged by James B. Eads to take charge of the engineering and construction of the jetties at the mouth of the river. These jetties vastly increased the ocean commerce of the Port of New Orleans, and also the railroad commerce of that city, developing the Mississippi Valley route. Dr. Corthell also served as chief engineer of the bridge over the Mississippi River at Louisiana, having a 444-ft. draw span, the longest in the world at that time.

Associated with Mr. Eads, Dr. Corthell, in 1880, went to the Isthmus of Tehuantepec, Mexico, to make surveys for the inter-oceanic ship railway and harbor. Returning to the United States in 1881, he devoted his time for three years to railroad construction, but from 1885 to 1887 he worked upon the project for the inter-oceanic route in Mexico, making an address before the commerce committee of the House of Representatives, U. S. Congress, which had before it the bill to charter the ship railway.

Built Many Bridges

Forming a partnership with George S. Morison, Dr. Corthell, from 1887 to 1888, engaged in the design and construction of railroads, bridges, harbors and waterworks. During this partnership many famous structures were completed—the Cairo bridge over the Ohio River for the Illinois Central Railroad, at that time the longest steel bridge in the world; the Nebraska City bridge over the Missouri River; the Sioux City bridge over the same river and two bridges in Oregon. About this time Dr. Corthell made several expert examinations of railroad properties for bankers in London and New York.

From 1889 to 1890 he was chief engineer of the St. Louis Merchants Bridge over the Mississippi River and chief engineer of the improvements at the mouth of the Brazos River in Texas, consisting of jetties built into the Gulf of Mexico, which increased the depth of water from 5 to 20 ft.

Reverting to railway work in 1890, he served for three years as consulting engineer for the Illinois Central and the Atchison, Topeka & Santa Fé Railway.

Improved Tampico Harbor

One of Dr. Corthell's biggest projects was the improvement of the harbor of Tampico, Mexico, for the Mexican Central Railroad, a work which he began in 1889. In 1885 he wrote a descriptive paper of these works for the Institution of Civil Engineers, London, for which he was awarded the Telford premium and the Watt medal. The striking feature of this work was that a deep channel was produced by the works constructed, without resort to dredging. In connection with his work at Tampico Dr. Corthell visited Europe in 1891 and examined 26 harbors to get special information for use on the Mexican project. On this trip also he was selected by the University of Chicago to examine leading universities and technical schools of Europe and to bring back data upon which to base the establishment of the University's School of Engineering and Architecture.

The Mexican government enlisted his services in 1892 to complete the National Railroad of Tehuantepec. He had charge of the surveys, plans and estimates for the harbors for this route and made a report to the Mexican government.

Retained by Argentine Government

In 1899 the Argentine government applied to the authorities at Washington for an engineer of broad experience to act in a consulting capacity in connection with its river and harbor improvements. Dr. Corthell was recommended and early the following year began an engagement which kept him in South America or engaged upon Argentine work until May, 1903. Thirty-six different subjects were referred to him for investigation and report. Dr. Corthell's work was held in such high regard that he was selected to represent the Argentine government as a delegate to the International Navigation Cogress held at Dusseldorf in 1902.

Upon his return to the United States he was engaged for eleven years as engineer for the Boston, Cape Cod & New York Ship canal, which is now in operation.

The Governor of New York State in 1904 appointed him upon the advisory board of consulting engineers to build the state Barge Canal, a position from which he resigned to give all his time to Brazilian work. During 1904-05 he was engaged on extensive commercial works in Brazil, at Para, in St. Catharina and Rio Grande do Sul.

Active at Congresses

The various international engineering congresses have always found Dr. Corthell an active participant either in person or by important papers. At a meeting in Brussels, where all but six of the seventy-one papers were in other languages than English, he prepared for the Department of State, which had selected him as a delegate, a résumé of the entire proceedings, which formed a volume of 245 pages. The International Engineering Congress held during the Columbian exposition was suggested by him and its success was largely due to his work as chairman of the executive committee having charge of that affair. When the recent Pan-American Scientific Congress in Washington, D. C., was contemplated the Department of State again called upon Dr. Corthell to aid in the organization of the meeting, and he rendered valuable assistance in making this affair a success.

A prolific writer upon engineering subjects, his printed papers fill many volumes. He was a member of many engineering and scientilc societies, both in this country and abroad, and was twice president of the American Institute of Consulting Engineers. Largely through his efforts this organization became a member of the Chamber of Commerce of the United States. Another of his activities concerned the establishment of a civilian reserve corps of engineers and he was one of the leaders, if not *the* leader in this project. Since his election to the presidency of the American Society of Civil Engineers Dr. Corthell had taken an active part in the proposal to have the society join the three other national engineering organizations in the Engineering Societies Building in New York.

To readers of the Engineering Record Dr. Corthell's name is already familiar. His most recent important contribution to this journal appeared in the issue of April 11, 1914, page 408, and was entitled "The War Against the Waves." It summarizes his many years of experience in protecting sea coasts from erosion by waves and is generally regarded as a classic in this field.

At the time of his death Dr. Corthell was seventy-six years old. His life was an eventful one and to a greater extent, perhaps, than any engineer living to-day did he come into close contact with important men and projects of national magnitude.

Appreciations of Dr. Corthell

Eminent Engineers Tell of His Work and Ability and Express Their Sorrow at His Departure

The Engineering Record has asked a number of those who knew Dr. Corthell well for appreciations of him as an engineer and as a man. They represent but a few of the expressions of sorrow and esteem that this journal has heard in the two days following his death.

Clemens Herschel

VICE-PRESIDENT, AMERICAN SOCIETY OF CIVIL ENGINEERS, (NOW RANKING OFFICER OF THE SOCIETY)

Seldom has a life been lived that was fuller of duty performed and a striving for well doing than that of Elmer Lawrence Corthell, dead at the age of 76, while president of the American Society of Civil Engineers and of the American Institute of Consulting Engineers.

The writer is glad to be allowed to say a few words in leave taking of a friend of more than 40 years.

Of a rather frail physique, unsparing of himself, it is a wonder that he endured as long as he did. Never was there a man more ardent in the pursuit of all that came within his compass; never a one more devoted to the manifold causes he took up.

To him was applicable Emerson's description of the volunteer laborer:

"So nigh is grandeur to our dust,
So near is God to man,
When Duty whispers low, Thou must,
The youth replies, I can!"

He was one of the few American civil engineers whose name was known among the engineers of many nations, and he will be sincerely mourned abroad no less than at home.

So farewell, brave heart, and as the ancients had it, "May the sod rest lightly upon thee."

William Barclay Parsons

CONSULTING ENGINEER, NEW YORK

In the death of Dr. Corthell the engineering profession has lost one of its ornaments, and many individual members have lost a valued friend. Corthell stood, as few others did, for high professional ideals. His experience was perhaps unique in the variety of his work and its widely scattered nature and location, but his views were equally broad. He had the ability to see and properly estimate the practical or commercial aspects of engineering problems as well as the scientific aspect. To others, and especially to younger men, he was always considerate and helpful and for this his death will be most keenly felt.

Percival Farquhar

CONSULTING ENGINEER AND BRAZILIAN RAILWAY BUILDER

It was my privilege to be actively associated with Dr. Corthell in various enterprises dating from early in 1906 until the latter part of 1912.

Dr. Corthell conceived the idea of deepening the channel into the Port of Rio Grande do Sul, Brazil, by the construction of jetties similar in principle to those by which the Mississippi and Tampico were deepened, and by the construction of a port there. The plans for this work and its initiation were carried out under his direction.

He was also for some years chief engineer in the construction of the Port of Para, at the mouth of the Amazon, afterward acting as consulting engineer.

His death comes as a great sorrow to me, and he is a man whom it will be difficult to replace.

F. A. Molitor

SECRETARY, AMERICAN INSTITUTE OF CONSULTING ENGINEERS

One of the most appealing things to my mind in Dr. Corthell's life and character was the broad way in which he approached his professional undertakings. He ever sought the public good. The constructive works that stand as monuments to his genius have accomplished much for the people of many countries, and many of these works were his own creation. Instead of being the agent of capital, he made capital his agent. I was deeply impressed with this when, over a year ago, I visited Rio Grande do Sul in Brazil, where improvements of the harbor were being completed under his plans. It is here, his last constructive work, that he "utilized one of the forces of nature to the usefulness of mankind" and opened to commerce a broad and fertile country. His unselfish devotion to this project, the personal hardships and obstacles encountered had much to do with the breaking down of his health. Through all the earlier negotiations and sometimes disappointments his unfailing energy, wonderful tact and the human qualities of his nataure overcame all the obstacles.

The last years of Dr. Corthell's life were devoted to the cause of creating a better understanding between the profession and the general public. His activities in this field were endless. Had he been spared a few years longer his growing influence would have finally impressed the public with the usefulness of the profession. This great human quality of his was exemplified also by his broad acquaintance, and his ever ready and unselfish response to public duty, as well as his remembrance and care for his subordinates and associates. A member of the younger generation who has worked for him and gained some of his inspiration and spirit may always be sure of preferment by saying, "I am one of Dr. Corthell's boys."

Onward Bates

PAST PRESIDENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

I was never directly associated with Mr. Corthell, but I have watched his career since my own boyhood. He was a man of high ideals, enterprising and courageous in advocating them. For half a century he has been a leader in the civil engineering profession, growing with it and contributing to its advancement. The record of his life will be helpful and inspiring to future engineers, and I trust it will be made accessible to them.

Julio F. Sorzano

PRESIDENT, THE PAN-AMERICAN CHAMBER OF COMMERCE

With the death of Elmer L. Corthell this country has lost not only one of its eminent engineers, but the one who has done more than any other man to make the American engineer known and respected in Latin-America.

During his long and important connections with large undertakings in Mexico, Brazil, Argentina and also with foreign governments as a consulting engineer, Corthell, by his sterling qualities, his broad and liberal mind, his inexhaustible generosity of character and, above all, by his lovable qualities as a man and as a friend, endeared himself to everyone with whom he came in contact.

It is fitting that such a man should have died while president of the American Society of Civil Engineers and president of the American Institute of Consulting Engineers.

He was a charter member of the Institution of Civil Engineers of Great Britain, an honorary member of the French Society of Civil Engineers and a founder of the Pan-American Chamber of Commerce. In every one of these institutions his loss will be deeply felt.

The Pan-American Chamber of Commerce loses in him a most devoted member, and I a beloved friend.

Dr. Romulo S. Naon

AMBASSADOR OF THE ARGENTINE REPUBLIC TO THE UNITED STATES

In the death of Dr. Corthell Latin America is deprived of the services of one of the most brilliant hydraulic engineers—one of the greatest in the world. Every project he undertook was worked out in a manner that showed Dr. Corthell's genius. The projects he has finished will stand as monuments to his memory as long as Latin America endures.

Dr. Domicio da Gama

AMBASSADOR OF BRAZIL TO THE UNITED STATES

South America has lost one of its most brilliant engineers in the death of Dr. Corthell. Probably his greatest achievement in connection with Brazil was his planning and completion of the harbor and improvements of Rio Grande do Sul. The work was undertaken by a French company, but they failed to accomplish the task. Dr. Corthell was the author of the present plans and the work has given the Brazilian Government entire satisfaction. Most of Latin America's great men have been patriots who shed their life's blood for their country. Dr. Corthell's work was of a different character, but just as helpful.

George F. Swain

PAST-PRESIDENT, AMERICAN SOCIETY OF CIVIL ENGINEERS

Mr. Corthell's energy and enthusiasm seemed without limit, and his devotion to the interests of his profession has placed all engineers under a heavy debt of gratitude to him. His ideals were of the highest, but never impracticable or visionary. He was always clear-headed and combined in rare degree the highest professional knowledge with sturdy common sense. He was a most delightful companion, intensely loyal to his friends and always ready to help others.

He will be greatly missed in the ranks of the profession and in the hearts of those who knew him well. His death will leave a void which only time and tender memories can partly heal. To his devoted wife, whose tender and unwearied care was such a support to him in his later years, the hearts of all who knew him will go out in deepest sympathy. He has passed into the great hereafter, but he has not only left material works to remind us of him, but an example that will be an inspiration to younger men.

In deference to Dr. Corthell the regular semi-monthly meeting of the American Society of Civil Engineers May 17 at the society house in New York City was adjourned immediately after the announcement of the death of Dr. Corthell, and the reading of a telegram of appreciation from Arthur P. Davis in behalf of the Washington Association of members of the society.

Attractive Routes Planned for Delegates to Waterworks Convention

Boat Trips on Hudson River and Atlantic Ocean May Be Included at Small Extra Expense by Delegates from the West

F. J. Bradley, 1223 Wabash Avenue, Chicago representative of the transportation committee, has arranged several routes to and from the annual convention of the American Water Works Association to be held June 5 to 9 in New York City. The Chicago party will leave the Twelfth Street station on the "Wolverine" of the Michigan Central Railroad, at 9.05 a.m., June 4.

For those who wish to return via the same route the round-trip fare will be $35. The return trip may be made on the Baltimore & Ohio, via Washington at an additional cost of $1.20 for the round trip, and on the Pennsylvania, at $38 for the round trip. Those wishing to include a boat trip may return via the Old Dominion Steamship Line to Norfolk, thence, via boat, to Washington and by the Baltimore & Ohio or Pennsylvania to Chicago. The trip via this route will cost $38, including berth and meals on steamer.

Boat Trips Planned

The return trip may also be made by either Sound or outside-line steamer to Boston, thence by rail to Montreal, and from there to Chicago via the Canadian Pacific or the Grand Trunk Railway. The cost of the round trip is $38.50. The return trip via Boston and Montreal can be made by rail for $39.75.

Those desiring to leave the train at Albany and complete the trip to New York by boat may check their baggage through to New York, by rail, without extra charge. The $5 extra fare will be refunded and railroad tickets exchanged at Albany to those wishing to make the river trip.

The transportation arrangements for delegates from Pittsburgh and the vicinity are in the hands of T. C. Clifford of the Pittsburgh Meter Company, East Pittsburgh. L. S. Barnard of the Hersey Manufacturing Company, Buffalo, is making transportation arrangements from that city. H. M. Lofton of the Columbian Iron Works, Chattanooga, is handling the arrangements for delegates from that section.

Elephant Butte Dam Completed

Work on the Elephant Butte dam at Elephant Butte, N. M., 120 miles north of El Paso, was completed May 13. The structure, on which work was started five years ago, forms a reservoir for the waters of the Rio Grande River, which will feed an irrigation system extending over 185,000 acres of New Mexican, Texas and Mexican land. This, the fifth of the government's big irrigation projects, will store the entire flow of the Rio Grande—enough water, it is estimated, to cover the State of Delaware to a depth of 2 ft.

President Wilson and Secretary of the Interior Lane wired their congratulations to the employees of the U. S. Reclamation Service engaged on the construction of the world's largest reservoir, which stores 856 billion gallons of water.

A description of the Elephant Butte project appeared in the Engineering Record of Oct. 4, 1914, page 368.

Pass Law Governing Contractors Operating in Maryland

A law relating to contractors doing a business of more than $5,000 a year in that state was recently passed by the Maryland Legislature, to become effective June 1. The measure compels a construction company with its chief office outside of the state, doing business in Maryland, to take out a license. The fee is $50 if the firm operates in the city of Baltimore and a like amount for each county of Maryland in which said firm may be operating. Resident firms operating in Maryland must take out a license at an annual cost of $10 for working in the city of Baltimore, and $10 additional for each county in which work is carried on.

Governor Signs New York Plant and Structures Bill

Governor Whitman, on May 12, signed the bill passed by the New York Legislature authorizing the change of the Department of Bridges of New York City to the Department of Plant and Structures. The new department will have the control of the construction and maintenance of buildings and structures previously under the jurisdiction of eight city departments. The present commissioner of bridges, F. J. H. Kracke, becomes commissioner of plant and structures. The forty-two bridges now controlled by the Department of Bridges will pass to the new department, but structures under the jurisdiction of the borough presidents, the Department of Water Supply, Gas and Electricity and the Department of Docks and Ferries, remain under the same control.

As stated on page 527 of the April 15 issue of the Engineering Record, the bill eliminates duplication of labor and equipment and authorizes the construction of a central repair shop at an expenditure of $1,500,000. The saving to be effected under the new organization is estimated at $1,000,000 a year.

Chicagoans to March for Preparedness June 10

A military preparedness parade will be held June 10 in Chicago, similar to the one held in New York City last Saturday.

National Fire Protection Association Holds Meeting at Chicago

Highest Grade of Fire-Resistive Construction Defined—Long Turn Elbows Recommended —All Officers Re-elected

Fire-resistive construction for office buildings was defined in a report by a committee of the National Fire Protection Association, May 9, 10 and 11, in Chicago. Ira H. Woolson is chairman of the committee and R. L. Humphrey presided at the session at which the report was presented.

The terms "full," "partial" and "temporary protection" are still to apply to structural materials and types of construction, but they are discontinued as applied to completed structures. Three grades of building in each class are to be recognized hereafter. The purpose is to secure, in grade A, the highest practical type of fire resistance. Grades B and C provide for permissible modifications. The committee report was accepted and referred to the executive committee with power to act.

A report on uses of wood in building construction was anticipated, but only a brief verbal progress report was submitted by Julius Franke, chairman, of New York.

Various changes in specifications for indicator posts were suggested by H. O. Lacount, chairman of the committee on hydrants and valves. The aim is to raise the standard of workmanship, to improve the present type of post by standardizing the target mechanism and to outline a new design for rising-stem indicator post which overcomes some of the criticisms of the target mechanism.

Long Turn Elbows Recommended

W. O. Teague, chairman of the committee on standardization of pipe and pipe fitting, brought in a progress report giving the results of an investigation by the Factory Mutual Laboratories on friction lost in screw and elbows of 2½, 4 and 6-in. diameter. In view of the conclusion that the friction loss of standard elbows is 50 to 100 per cent greater than that of long-turn elbows, the committee recommended the use of the latter.

More or less criticism was expressed in regard to the practice of permitting reports to be presented and passed without full previous consideration. It was explained that specifications may thus be promulgated which are not representative. The matter was placed in the hands of the executive committee to formulate a policy requiring all reports to be prepared well in advance so that they might represent mature consideration. This would remove possibility of criticism that insurance interests were trying to foist on the public anything to which they were not entitled.

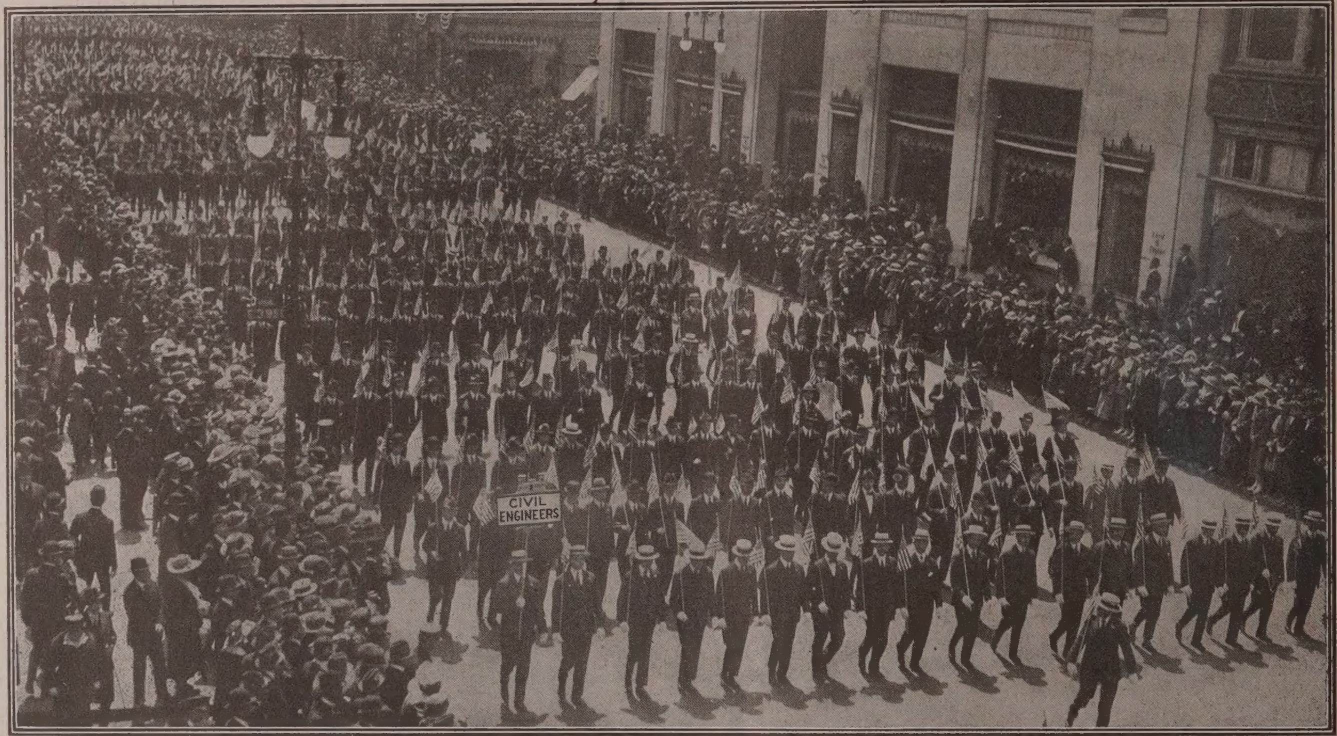
All the officers were re-elected: Charles E. Meek, president; Louis Wiederhold and D. Everett Waid, vice-presidents; Franklin Wentworth, secretary-treasurer.

Amended Lockwood - Ellenbogen Bill Passes Legislature

The Lockwood-Ellenbogen bill providing for unified inspection of buildings in New York City, which was defeated by the state Legislature last year, has been revised and amended and was finally passed this year and signed by Governor Whitman, May 11. It consolidates, in a board of standards and appeals, the power to make and amend rules and regulations for the construction, alteration and structural changes in and removal of buildings in New York City. These matters were formerly handled by the superintendents of buildings of the five boroughs, the fire commissioner and the state commissioner of labor. Control of waterfront property of the city and the jurisdiction of the tenement-house department are not, however, to be infringed upon.

The board of standards and appeals is to consist of the fire commissioner, the superintendents of buildings, the chief of the fire department and six other members appointed by the mayor. Of these six appointed members the mayor designates a chairman, who shall be an architect or structural engineer of at least fifteen years' experience and shall devote his whole time to the work. The mayor also appoints a secretary. Of the other appointed members there must, at all times, be one architect, one structural engineer and one builder, each with at least ten years' practical experience. The mayor has power to remove and to fill vacancies among the appointed members of the board.

The rules of the new board will not take effect until Oct. 1, 1916.



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More Than 125,000 March in New York City's Preparedness Parade May 13—Engineers Number 6660

A PART OF THE CIVIL ENGINEERS' DIVISION OF THE MILITARY PARADE HELD IN NEW YORK CITY, MAY 13, IS SHOWN IN THE PICTURE. MORE THAN 125,000 EARNEST CITIZENS OF ALL OCCUPATIONS TOOK PART. THE ENGINEERS' DIVISION, WHICH WAS DIVIDED INTO EIGHT SECTIONS, TOTALED OVER 6660 TECHNICAL MEN AND, IN ADDITION, BOASTED EIGHT BANDS COMPOSED OF 384 MUSICIANS. THE MARCHING WAS CONTINUOUS FROM 9.35 A. M. UNTIL 9.40 P. M. THE ESTIMATED TIME FOR ONE LINE TO COVER THE ROUTE FROM THE CITY HALL TO FIFTH AVENUE AND FIFTY-SEVENTH STREET WAS ONE HOUR AND FIVE MINUTES. MILITARY OFFICERS WHO REVIEWED THE PARADE SAID THAT THE UNTRAINED CITIZENS MARCHED WITH UNEXPECTEDLY GOOD PRECISION. LIEUT.-COL. MERRITT H. SMITH WAS MARSHAL OF THE ENGINEERS' DIVISION; CAPT. GEORGE PERRINE, COL. E. W. VAN C. LUCAS AND COMMANDER EDWARD C. FITZGERALD LED THE FIRST, SECOND AND THIRD ENGINEERS' DIVISIONS RESPECTIVELY. J. WALDO SMITH AND GANO DUNN, CHAIRMEN, J. S. LANGTHORN, SECRETARY, J. P. HOGAN, ASSISTANT SECRETARY, WILLIAM BARCLAY PARSONS, AND ARTHUR S. DWIGHT, OF THE MILITARY LECTURE COMMITTEE, MARCHED JUST AHEAD OF THE FIRST DIVISION OF ENGINEERS.

$30,000,000 Building Project Proposed on Long Island

An American Versailles is to be built on the north side of Long Island, New York, at an estimated cost of $30,000,000. According to Penrhyn Stanlaws, president of the organization, ground will be broken about July 15. About 180 acres of land have been purchased and plans are being completed by Carrère & Hastings, architects, 52 Vanderbilt Avenue, New York City.

Building Collapses at Akron

The Beacon-Journal Building at Akron, Ohio, collapsed May 15. Ten people are reported killed and twenty-five seriously injured. The accident is said to have been caused by dynamiting in an adjoining excavation.

Dinner to George S. Bartlett

During the meeting of the Portland Cement Association in Chicago last week friends of George S. Bartlett, one of the best known men in the cement industry, joined in tendering him a testimonial dinner at the Hotel Blackstone. W. S. Mallory, president of the Edison Portland Cement Company, was toastmaster, and among the speakers were the following officers of cement companies: John B. Lober, Vulcanite; A. Y. Gowen, Lehigh; B. F. Affleck, Universal; Richard Hardy, Dixie; L. T. Sunderland, Ash Grove, and T. G. Dickinson, Marquette. Edward N. Hines and Robert W. Lesley also spoke.

In the foreword to the souvenir menu are found these words:

"A company of men is here assembled, because of the admiration, yes, the love, we bear for one man. Through years we have worked with him in close association. And now and then we have fought him in the changing fortunes of the business war. But whether our interests were his interests, or otherwise, as we have known him better we have loved him more."

While Mr. Bartlett's acquaintance in the cement industry is very large, he also numbers a great host of engineers among his friends. He has been constantly engaged in the cement and building-supply business since he started in it in Milwaukee some thirty years ago. For some years past, as a member of the promotional department of the Universal Portland Cement Company, with headquarters in Chicago, and as vice-president of the Edison Portland Cement Company, with offices in New York, he has been engaged in the promotion of concrete roads.

Wreck Bridge at Manchester to Get Skeleton of Dinosaur

A $10,000 bridge will be torn down at Manchester, Conn., to secure the skeleton of a dinosaur embedded in the sandstone piers and abutments. The structure was erected more than thirty years ago, at which time the presence of the bones was mentioned. The Peabody Museum of Yale University will pay for wrecking the old bridge and constructing a new one.

Col. John Biddle Made Superintendent of West Point Academy

Col. John Biddle, Corps of Engineers, U. S. A., will be transferred from Baltimore, Md., to become superintendent of the U. S. miliary academy at West Point, effective July 1. Colonel Biddle, as engineer of the Eastern Division, was in charge of the works for defense of Baltimore and of many improvements of the harbor at Baltimore. He has just completed a survey and plans for the improvement of the channel approaches to that harbor.

Colonel Biddle was graduated from West Point in 1881 and was commissioned in the Corps of Engineers that same year. In 1902 he was made captain. During the Spanish war he was chief engineer of the U. S. volunteers. He has also served in the Philippines, Porto Rico and Cuba. In 1907 he was detailed in charge of works in the Sacramento and San Joaquin rivers, in California. He was appointed military observer to Austria in 1914 and succeeded Major Horton W. Stickle in charge of river and harbor works at Baltimore in 1915.

Ask Government to List Engineers' Qualifications

A set of resolutions passed May 9 by the American Association of Engineers at its annual convention requests the U. S. War Department to furnish blanks for recording engineers' qualifications and other useful information. The report of the secretary showed that the membership has reached 700 and approximately $12,000 has been saved by the securing of positions for engineers through the service clearing house instead of through employment agencies. W. J. Mauer was appointed member of the board of directors to replace the retiring president, W. D. Wilcox. Garrison Babcock was elected president.

What Engineers and Contractors Are Doing

Frederic C. Dunlap, who resigned as chief engineer of the Bureau of Water, Department of Public Works, Philadelphia, in 1912, has again been engaged by the department, in an advisory capacity, in connection with sewage-disposal work. Mr. Dunlap was born in 1869 at Mullica Hill, N. J. He was educated at the Pennsylvania Polytechnic School and began engineering work in 1888. In 1890 he engaged in the practice of consulting engineering and from 1894 to 1896 served as engineer for the Union Hydraulic Works, of Philadelphia. From the latter year until 1900 he was engaged in various hydroelectric and water-supply developments until he joined the Philadelphia engineering department as assistant engineer on designs for water-supply improvement. He was later placed in charge of the Torresdale filters and, still later, made chief of the Bureau of Water, in charge of the city's water purification plants, pumping stations and distribution system.

W. C. Coles was recently made pilot engineer of the Baltimore & Ohio Railroad, with headquarters at Wheeling, W. Va.

C. E. Painter has resigned as assistant city engineer of Newton, Kan., to become connected with Black & Veatch, consulting engineers, of Kansas City, Mo.

R. E. Kennedy was recently appointed pilot engineer for the Baltimore & Ohio Railroad, at Relay, Md.

Charles Wilson, of the firm of Kirk & Wilson, has been appointed a member of the engineering staff of Youngstown, Ohio.

William C. Campbell has resigned as superintendent of public works for Columbus, Ga., to engage in the contracting business at Charlotte, N. C. Mr. Campbell was graduated from the Georgia School of Technology in 1904 and has been connected with the engineering department of Columbus ever since.

Schley Gordy has been promoted to the position of superintendent of public works for Columbus, Ga. He has been in the city's employ for six years as assistant to W. C. Campbell, whom he succeeds.

Edmund M. Blake, for several years in charge of the Neponset River improvement for the Massachusetts Department of Health, has been made engineer for the Holbrook, Cabot & Rollins Corporation. He will work on the construction of the new drydock at Boston. Mr. Blake was recently engineer on the Arrowrock dam, at Boise, Idaho.

J. E. Gillespie, state-aid highway engineer, has been transferred from Grand Rapids, Mich., to Milwaukee, Wis.

Montague Ferry, consulting engineer, of Chicago, has removed his office to 20 South La Salle Street.

H. W. Ker, formerly shop superintendent for the Snyder Electric Furnace Company, of Chicago, is now connected with the Wapakoneta Machine Company, of Wapakoneta, Ohio.

Edward R. Stapley has resigned as instructor in civil engineering at Cornell University to assume the duties of resident engineer for the town of Wilson, N. C. Improvements costing nearly $500,000 are under construction.

Charles Cottingham, consulting engineer, of Danville, Ill., has removed his office to the Daniel Building.

Bartlett & Ranney, consulting engineers, of San Antonio, Tex., have been retained to prepare plans for a 500-kw. steam turbo-generator for the Landa Industries, at New Braunfels, Tex. The firm will also investigate and report on improvements of the water supply at Terrell, Tex., and sewage disposal at Dallas.

W. H. Coverdale & Company, consulting engineers, of New York City, will hereafter practise under the firm name of Coverdale & Colpitts.

H. J. Fairbanks, formerly recorder of a field party on the Long Island Railroad, is now office computer with the Interstate Commerce Commission at Washington.

Samuel E. Flexer has left the employ of the Lehigh Portland Cement Company to become connected with the Clinchfield Portland Cement Corporation, at Kingsport, Tenn.

Stephen L. Selden has resigned from his position as vice-president of J. G. White & Company to practise law.

A. M. Truesdell has left the employ of the bridge department of the Oregon Short Line Railroad to accept a position with the American Bridge Company, at Gary, Ind.

E. W. Blodgett, formerly with the Aberthaw Construction Company, of Boston, is now connected with the Gilbert & Banker Manufacturing Company, of Springfield, Mass.

Dr. W. C. Huntington will leave his position as head of the Chicago office of the Bureau of Foreign and Domestic Commerce to become commercial attaché at Petrograd, May 31. Dr. Huntington brings to the position a technical training acquired at Columbia University and at the Königliche Technische Hochschule at Aix-la-Chappelle. He has had five years' experience with two of the largest engineering firms in the United States.

C. D. Flanders, for the past three years superintendent of construction for Busk & Wind, contractors, of Omaha, has been appointed general foreman of construction for James Stewart & Company. Mr. Flanders was at one time connected with F. P. Gould & Son, and was also previously with his present employers as general foreman on the U. S. National Bank Building at Omaha. In his present position Mr. Flanders has charge of the construction of new bulkheads and piers for the Norfolk & Western Railway at Norfolk, Va.

L. W. Swett has been made superintendent for the Brooks Construction Company, of Fort Wayne, Ind. He has also been made a member of the Joint Committee on Military Engineering.

Frank Sheets has been promoted to the position of assistant maintenance engineer with the Illinois highway commission. Besides having supervision of the maintenance of state-aid roads, he is required to lecture on road building and maintenance.

J. M. Heffelfinger is assistant resident engineer with J. J. Morgan, consulting engineer, of Columbus, Ohio. He is at present on construction work at the Columbus sewage-disposal plant.

R. B. Siler is now employed on government railway valuation work with the Interstate Commerce Commission, with headquarters at Chattanooga, Tenn.

R. D. Brown has resigned as transitman with the U. S. Department of Agriculture to become associated with Francis W. Wilson, consulting engineer, of Hanover, Mass.

E. H. Miller is now engineer in charge of paving of streets and construction of two reinforced-concrete bridges at Berkeley Springs, W. Va.

Carl W. Bucholtz, formerly division engineer on the Meadville division of the Erie Railroad, has been made trainmaster of the Marion division.

C. E. Lesher has accepted a position with the engineering department of Jackson, Mich.

A. C. Cornelison, who recently returned from Panama to accept an appointment as superintendent of the Mexia Quarry Company, is now connected with the Honolulu Construction Company, of Honolulu, T. H.

Frederic Bass, consulting engineer, of Minneapolis, has been retained to make preliminary investigations for an improvement of the waterworks at Minot, N. D.

Edward A. Collins has been elected permanent secretary of the Builders' and Traders' Exchange of Pawtucket, R. I.

Henry Hornbostel and George Wild have been appointed consulting city planner and associate city planner respectively by the city-planning commission of Johnstown, Pa.

Albert Buchanan, chief engineer and draftsman of the London Street Railway, London, Ont., was the first to enlist in the Western University Stationary Hospital when recruiting started May 13. He is a graduate of the Royal Technical College, Glasgow, Scotland.

Eric G. Kingwell, formerly city engineer of Kamloops, B. C., has joined the Kootenay pioneer overseas battalion as lieutenant.

I. E. Goodnier, of Goldfield, Nev., was appointed engineer of the Paradise irrigation district, Butte County, California, at a meeting of the board of directors May 3.

H. Moseley has been re-elected city engineer of Dallas, Tex.

J. D. Wardle, formerly chief engineer of the Iowa Railway & Light Company, has been engaged to improve the Mount Vernon

(Iowa) sewerage and sewage-disposal systems. Mr. Wardle was for some time city engineer of Cedar Rapids, Iowa.

RAYMOND HUNT has been made consulting engineer for the Tidewater Power Company, at Wilmington, N. C.

W. W. RANDOLPH was recently appointed development engineer for the Tidewater Power Company, at Wilmington, N. C.

E. D. STAPP has been appointed assistant city engineer of Davenport, Iowa.

THOMAS K. MYLER, formerly with the T. A. Gillespie Company on the construction of the East Liverpool (Ohio) filtration plant, has entered the engineering department of the American Bridge Company, at Gary, Ind. Mr. Myler was graduated from the University of Pittsburgh in 1911. He was then employed by the engineering department of the Pennsylvania Railroad and later by the Chicago, Milwaukee & St. Paul. In 1913 he became construction engineer for the Clinton Gas & Electric Company, of Clinton, Iowa, and later was made assistant city engineer of that city. He has been with the Gillespie Company since 1915.

WILLIAM MCCRABB was recently appointed general foreman on the Pennsylvania Railroad reinforced-concrete viaduct across the Susquehanna River, at Harrisburg, Pa., for which the Robert Grace Construction Company has the contract. Mr. McCrabb was engaged on the construction of the viaduct in Baltimore over Jones Falls and was general foreman at lock 1 on the Welland canal. He has also been connected with the J. G. White Engineering Corporation on two water-power developments in Tennessee.

E. S. HATHAWAY has been appointed city engineer of Missoula, Mont.

L. A. NICHOLSON, engaged in consulting engineering practice for the past twenty-six years, has been appointed city engineer of Tacoma, Wash.

MONTY HULSE has been appointed city engineer of the town of Sumner, near Tacoma, Wash.

F. R. MARSH, city engineer of Great Falls, Mont., has been reappointed for two years.

C. R. MOORE, of Hamilton, Ont., has been appointed assistant to H. G. Kelley, chief engineer and vice-president of the Grand Trunk Railway.

GEORGE D. MACKIE, city engineer of Moose Jaw, Sask., has been appointed a member of a Royal Commission which will investigate the work of the provincial highways department.

L. G. IRELAND, general manager of the Brantford Municipal Railway and the Brantford electrical commission, has tendered his resignation. He will take complete charge of the Ontario hydro commission and of the new Eastern Ontario hydro power development project, on which the government plans to expend many millions. Mr. Ireland was with the hydro commission for five years before going to Brantford.

ELISHA LEE, assistant general manager of the Pennsylvania Railroad at New York; W. L. Seddon, vice-president of the Seaboard Air Line Railway, and L. W. Baldwin, general manager of the Central of Georgia Railway, are three—the three who have risen through the engineering departments—of the seventeen railroad officials appointed to represent the railroads in the negotiations regarding the demands of the trainmen for a basic eight-hour day. A series of conferences with representatives of the brotherhoods will begin in New York City June 1.

OSCAR D. CHRISMAN has been appointed city engineer of Springfield, Mo. His first work with that city was as field engineer. He acted as draftsman of the public works department and later was appointed assistant engineer, which position he has held since 1912.

COL. HARRY TAYLOR, Corps of Engineers, U. S. A., principal assistant to the chief of engineers at Washington, D. C., will be transferred to New York City, June 1, to become division engineer of the Eastern Division.

COL. HENRY C. NEWCOMER, Corps of Engineers, U. S. A., resident member of the board of engineers for rivers and harbors, Washington, D. C., will succeed Col. Harry Taylor as principal assistant to the chief of engineers, at Washington.

LIEUT.-COL. FRANCIS R. SHUNK will be made resident member of the engineer river and harbor board, at Washington, June 1. He is now in charge of river and harbor work in the vicinity of Pittsburgh.

LIEUT.-COL. EDGAR JADWIN, assistant to the chief of engineers, Washington, D. C., will soon assume charge of river and harbor work in the vicinity of Pittsburgh.

HALFORD ERICKSON, whose resignation from the Railroad Commission of Wisconsin was noted in the April 29 issue, has formed a partnership with William Hagenah, and opened offices in the First National Bank Building, at Chicago. The firm of Hagenah & Erickson will conduct railroad, public utility and financial investigations, embracing appraisals, cost analyses and rate studies. Mr. Hagenah was chairman of the board of arbitration which conducted an investigation into Chicago's gas rates. Mr. Erickson had served on the Railroad Commission of Wisconsin since its creation in 1905, and the enviable reputation which this commission has gained is attributed in large measure to Mr. Erickson's efforts and ability. He was born and educated in Sweden, and came to the United States in 1884. He continued his education in Minneapolis and entered the service of the Chicago, St. Paul, Minneapolis & Omaha Railroad in 1890. After serving in various capacities with that company, he was appointed a labor commissioner of Wisconsin in 1896. He continued in that office until 1905, when he was appointed a member of the original Railroad Commission of Wisconsin.

T. M. VINTON, formerly of the firm of Tucker & Vinton, engineers and constructors, New York, has joined the New York office of the Trussed Concrete Steel Company.

Obituary Notes

JOHN L. KIEF, railroad contractor, of Mountain Home, Idaho, died recently. Mr. Kief was born at Wilmington, Del., in 1859. His first experience was gained in the employ of various railroads. He soon entered the contracting business and did a great deal of work for the Union Pacific and Atchison, Topeka & Santa Fé railways. He also assisted in the construction of storage reservoirs, diversion dams and canals for the Pecos Irrigation & Improvement Company of New Mexico.

HENRY ROHWER, consulting engineer, of St. Louis, died May 5 in that city. He was born in the province of Holstein, Germany, in 1847 and was graduated from the Royal Polytechnic High School in 1869. He came to the United States that year and entered railway service as topographer for the Burlington & Missouri River Railway. He had risen to the position of chief draftsman and engineer in charge of location and construction in 1873, when he became resident engineer for the Omaha & Southwestern Railroad. In 1874 he began the practice of consulting engineering at Omaha and was made city engineer in 1877. He left the employ of Omaha in 1881 to become assistant engineer of the Union Pacific Railway. He went to the Oregon Short Line in 1883 and remained with that road until his appointment with the Omaha Belt Railway when that road became part of the Missouri Pacific Railway in 1887. He was made chief engineer of that road in 1901 and resigned in 1905 to engage in private practice.

CHARLES W. FENN, consulting engineer, of Portland, Me., died recently in that city. Mr. Fenn was born in Jersey City, N. J., in 1854 and was graduated from Yale University in 1876. His first work was in the engineering department of the Chicago, Burlington & Quincy Railroad. He later opened offices in Portland as consulting engineer, and when the Portland water district was formed he was put in charge of construction. He has also been associated with the construction of several of Portland's large buildings.

PATRICK WALSH, chief engineer of the Quindare station of the Kansas City (Mo.) water department, died May 9, at the age of 65.

RICHARD GENTRY, general manager and president of the Kansas City, Nevada & Fort Smith Railway, died recently at Kansas City. He was also chief engineer on the construction of that road, which is now a part of the Kansas City Southern.

CLOUD CLIFFORD CONKLING, engineer for the Lackawanna Steel Company, died May 8 at Buffalo. He was born in Rensselaerville, N. Y., in 1862 and was educated in the public schools of Scranton, Pa. He studied civil and mining engineering while employed as rodman on the Erie & Wyoming Railroad and during 1882, while on a water-supply survey of Ramapo Valley, N. Y. He took a special course of study at Williston Seminary during 1882 and 1883 and was draftsman and transitman at Scranton, Pa., under J. H. Rittenhouse, in 1884 and 1885. Mr. Conkling served for 12 years in the National Guard, State of Pennsylvania, and was sergeant-major of the Thirteenth Regiment at the time of his retirement. He entered the department of civil and mining engineering of the Lackawanna Iron & Steel Company in 1886 as rodman. He was successively transitman, assistant engineer and chief of the engineering department. He had charge of the design and construction of all civil engineering work for the company, including the construction of the company's plant at Buffalo, N. Y., and the design and construction of railroad yards, sewers, villages, canals, harbor work, the South Buffalo Railroad and foundations of all kinds. He was chief engineer of the South Buffalo Railroad and chief civil engineer of the Lackawanna Steel Company until 1904, when he left the direct employ of the company to practise consulting civil engineering at Buffalo. Mr. Conkling designed and patented modifications of the original design of Lackawanna steel sheet piling and was instrumental in bringing to a successful completion the designs and sections of Lackawanna steel sheet piling now rolled by that company. In October, 1913, he returned to the Lackawanna Steel Company as chief engineer in the steel sheet piling engineering department, which position he held until the time of his death.

Civil Service Examinations

United States.—The Civil Service Commission announces an open competitive examination for aid in the Coast and Geodetic Survey, June 7 and 8, salary $900 at time of appointment. Applicants must be between 18 and 25 years of age. Apply for Form 1312 at any of the usual civil service branches.

Examinations Previously Announced

Date		See Eng. Record
June 3	—Assistant electrical engineer, New York State...	May 13
Aug. 21-25	—Second lieutenant, civilian candidates	April 1